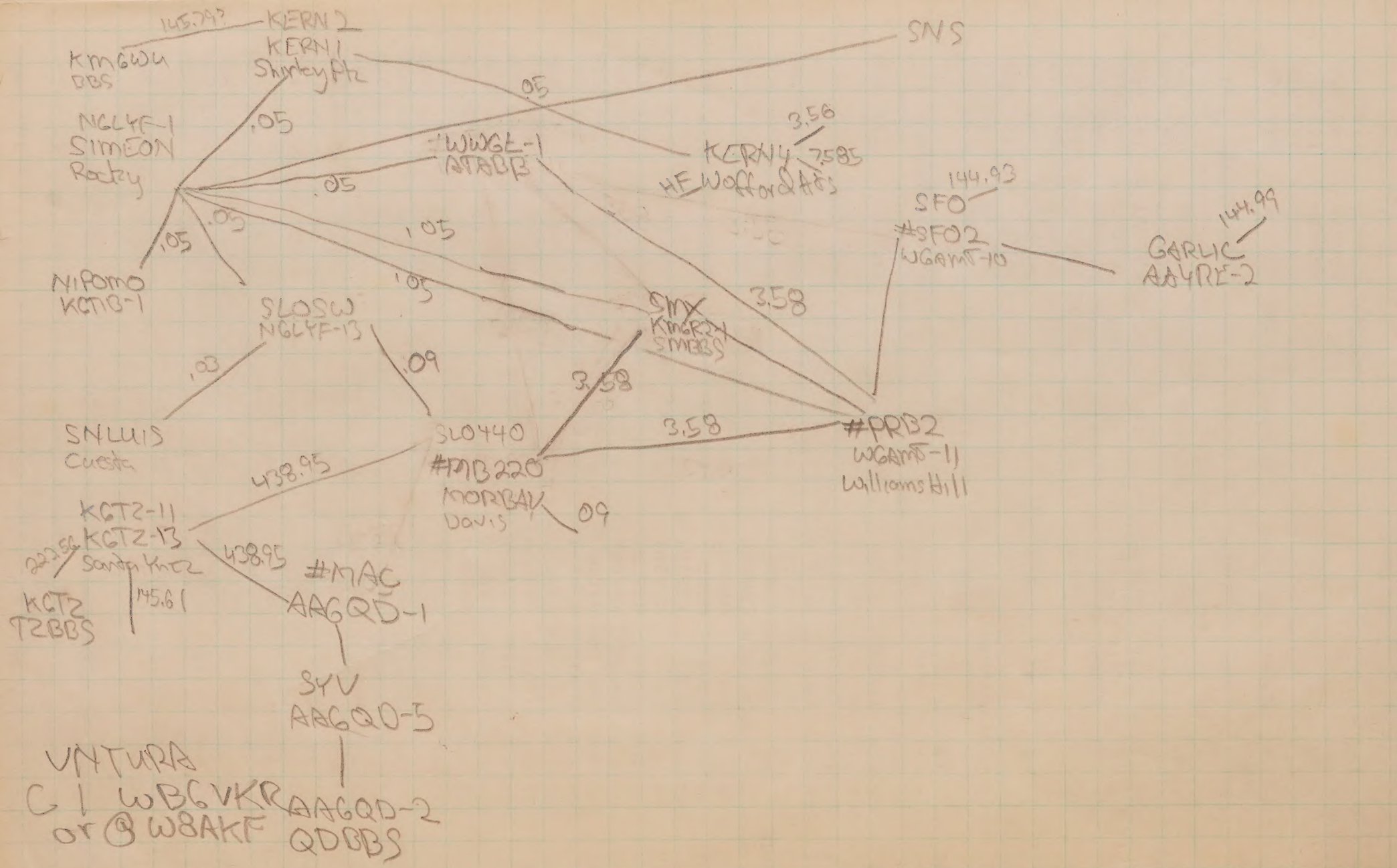
145.29?
KERN 2
KERN 1
Shirley Pk
KM6WG
DBS
SNS
.05
NGLYF-1
SIMEON
Rocky
.05
WWGL-1
ATABB
3.56
KERN 4
7.585
HF Wofford AES
.05
144.93
SFO
#SFO2
WGAMT-10
144.99
GARLIC
AA4RE-2
.05
.05
.05
.05
NIPOMO
KGTB-1
3.58
SMX
KM6RZY
SMBBS
SLOSW
NGLYF-13
.03
.09
3.58
SNLUIS
Cuesta
SLO440
#MB220
MORBAY
Davis
09
3.58
#PRB2
WGAMT-11
Williams Hill
438.95
KGTZ-11
KGTZ-13
Sandia Knoll
438.95
#MAC
AAGQD-1
224.56
145.61
KGTZ
TZBBS
SYV
AAGQD-5
VNTURA
C | WB6VKR
or @ W8AKF
AAGQD-2
QDBBS

AA6UP's California 2 Meter BBS/Nodes by County (1200 BD/AX25 ONLY)

Key: A-BBS/Node B-BBS only E-Emergency (Dedicated System) N-Node only

ALAMEDA

	N6EEO	144.97B
	WA6YHJ-1	145.09B
FMTMB	N6QMY-1	145.79B
FMTNOD	N6QMY-2	145.09N
FMTNOD	N6QMY-2	145.79N
NAVY	W6PW-6	144.99N
NBAY	WD6CMU-1	144.97N

AMADOR

PINGRV	KF6GY-1	144.99N

CONTRA COSTA

	AA6QR	145.73B
	KA6FUB	144.99B
	KI6WE	144.97B
	KI6YK	144.93B
	W6CUS-1	145.09B
	WA6HAM	145.73B
	WD6CMU	144.97B
BALD	KA6FUB-2	145.09N
HIGH	KA6FUB-3	144.93N
KREG	KA6FUB-1	144.99N
ORINDA	AA6QR-11	145.73N
P1TS	KI6V-1	144.97N
SKIP	KC6JEM-1	144.97N
VOL	WA6BTH-3	144.97N

EL DORADO

	WA6EWV-1	144.97B
APPLE	WA6BTH-2	144.97N
PLC	N6RME-7	144.91E
PLC	N6RME-7	145.07N
SOME	WA6BTH	144.97N

FRESNO

	N6ZGY	145.73B

HUMBOLDT

	WA6TVO	145.01B
	WB6LYE	145.73B
EUREKA	WB6LYE-4	145.73B
PRCE	WB6MYF-10	145.73N

KERN

	KC6OVD	145.07B
BIRD	KC6UTH-4	145.61N
CENCA2	KM6WU-2	145.79N
KERN	KM6WU	145.79B
KERN1	KM6WU-1	145.79N
YBNBBS	WA6YBN-4	145.05A
YBNBBS	WA6YBN-4	145.61A

KINGS

	N6OA	144.99B
LEM	N6NPZ-1	144.99N

LOS ANGELES

	KK6HS-9	146.745B
	N6YN	145.05B
	W6IN	145.05B
	WA6FWI-3	146.745B
	WB6YMH-2	145.36B
	WD6EHR-2	146.745N
#GFRN	WB6YMH-4	145.36N
BRNTWD	WB6ZRC	145.07N
JESBBS	KB6JES	145.03B
JESNDE	KB6JES-1	145.03N
LA	K6VE-1	145.01N
LABBS	K6VE-5	145.01B
LABBS	K6VE-5	145.03B
LADFX	N6GPP-1	146.745N
LANODE	K6VE-10	145.01N
LANODE	K6VE-10	145.03N
MALIBU	N6FDR-2	145.65N
MNTBLD	KB6RAA-1	145.03N
PALM	KB6ZBI	145.01A
PALM	KB6ZBI	145.09A
PALM	KB6ZBI-9	145.01N
PAS911	W6KA	144.91N
PV	WB9VNT-2	145.09N
RAABBS	KB6RAA	145.03B
SFVBBS	WB6WFH-1	145.63A
SFVLAN	N6CDJ-1	145.63N
SFVNET	WB6WFH-7	145.63A
SGVBBS	W6QFK-2	145.65A
STN12C	W6IN-1	145.05N
UNQBBS	K6UNQ	145.05B

MERCED

	K6RAU-1	145.09B
ATWATR	WA6PIC-1	145.09N

MENDOCINO

	K7WWA	145.79B
ARENA	WA6ZTY-4	145.73N

MONTEREY

	K6LY	144.97B

NAPA

AMCYN	WZ6X-2	144.99N

ORANGE

	KB6QFT-2	145.07B
	WF6O	145.03B
	WF6O	145.05B
#RKYMB	N6RKY-2	145.03N
RKYBBS	N6RKY	145.03B
SJCP	WA6LEW-2	145.09N

RIVERSIDE

	KD7XG-1	145.05B
	KJ6VC-1	145.69B
	N6KZB	145.07B
	N6OKS	145.69B
	N6YIH	145.65B
	NR6P-1	145.07B
	W6TJ	145.07E
	W6TJ-6	145.07E
	W6TJ-7	145.07E
BOX07	N6KZB-6	145.07N
ELS07	N6KZB-2	145.07N
HMT	N6OKS-2	145.69A
PNE07	N6KZB-10	145.07N
RIMO3	N6KZB-7	145.03N
ROSA07	N6KZB-4	145.07N
WW07	N6KZB-9	145.07N

SACRAMENTO

	KD6XZ-1	144.97B
	KG6XX-1	145.07B
	WA6NWE-1	145.09B

SAN BENITO

	KE6BX	144.93B

SAN BERNARDINO

	KC6LHA	143.03B
	KC6LHA	145.63B
	N6ADV	145.05B
	WA6PEZ-1	145.09N
BARSTO	WA6PEZ-3	145.01B
GVTBBS	KB6GVT-1	145.05B
PEZBBS	WA6PEZ	145.05B
RIA3	KB6GVT-3	145.03N
RIA5	KB6GVT-5	145.05N
RIA6	KB6GVT-6	145.61N
UK1PA	KA6FQN	145.07N

SAN DIEGO

CVNODE	KO6Y-3	144.76N
MPK	KA6DAC-1	145.05N
NZN	KC6NZN-1	145.01N
NZN	KC6NZN-1	145.05N
NZNBBS	KC6NZN	145.01B

AA6UP's California 2 Meter BBS/Nodes by County — 1 Jan 1993

(1200 BD/AX25 ONLY)

Key: A-BBS/Node B-BBS only E-Emergency (Dedicated System) N-Node only

** SAN DIEGO (cont.) **

NZNBBS	KC6NZN	145.05B
OTAY	WB6WLV-1	145.01N
PALMAR	N6NWG-1	145.05N
SAN	AA4CD-1	145.05N
SEEBBS	AA6QN	145.01B

** SAN FRANCISCO **

#SFBBS	W6PW-3	144.99A
SF	WB9LOZ-2	144.99A
SFW	W6PW-1	144.99N

** SAN JOAQUIN **

	W6SF	144.99B
	WA6KTK-2	145.79B

** SAN LUIS OBISPO **

	WW6L-1	145.05A
SLOBBS	W7AZF-1	145.09A

** SAN MATEO **

	KA6EYH	145.07B
	KA6JLT-3	145.73N
	N6THN	144.99N
	WB6GZT	144.99N
#RWCBB	WA8DRZ-6	144.99B
MPBBS	KA6JLT-2	145.73A
RWC	WA8DRZ-7	144.99N
SSF2	KA6EYH-2	144.99N

** SANTA BARBARA **

	AA6QD-2	145.05B
	AA6QD-2	147.585B
	N6AZD	145.05B
FIG	AA6QD-3	147.585N
LOMPOC	WA6VPL-1	145.01N
SBA	K6TZ-13	145.05N
SBA	K6TZ-13	145.07N
SBA05	K6TZ-2	145.05N
SBABBS	K6TZ	145.07B
SMBBS	N6QDC	145.05B
SMX	N6QDC-1	145.05N
SYV	AA6QD-5	145.05N
TOXIC	N6LYF-5	147.585N
WATER	N6QDC	145.05N

** SANTA CLARA **

	K3MC	145.09B
	N0ARY-1	144.93B
	N6IIU-1	145.07B
	WB6ZVW	144.99N
#LGBBS	N6LDL	144.97B
#LGNOD	N6LDL-1	144.97N
ALMADN	KB5IC	145.73A
GARLIC	AA4RE-2	144.99N
GVPSBB	AA4RE-1	144.99B
SFO	W6AMT	144.93N
SNJOSE	KB8FOU	145.07N
TINO	WA6VFD	144.97N
TINO-1	WA6VFD	144.97N

** SANTA CRUZ **

	KB6IRS	145.09B
	KG6EE	145.07B
	KI6EH	145.07A
#BCBBS	W8GEC	145.73B
#BLBBS	N6MPW-7	145.79A
#BLNOD	N6MPW-6	145.79N
#SCNOD	KI6EH-1	145.07N
BCNOD	W8GEC-1	145.73N
MRYBBS	N6IYA-2	145.09A
SCZNOD	KG6EE-1	145.07N
SNTCRZ	N6MPW-1	145.09N

** SHASTA **

	N6ECP	145.09B
BRNY	KI6WG-1	145.09N

** SOLANO **

DIXBBS	WA6RDH	145.01A
FYBBS	KJ6FY-1	144.93A
SOLANO	KJ6FY	144.93N
VACA	WA6RDH-1	145.01N

** SONOMA **

	KC6PJW	145.73B
#ROHN	WX3K	145.73A
ROHN	WX3K-1	145.73N
SONOMA	N7SOF-1	145.73N

** STANISLAUS **

	N6KMR	145.07N
	N6KMR-2	145.07N
SARA	N6KMR-7	145.07N

** SUTTER **

YCBBS	KE6LW-1	144.99A
YUBA	KE6LW-2	144.99N

** TUOLUMNE **

	KK6SZ-2	144.97B
SON	KK6ZZ-2	144.99N
SONORA	KK6ZZ-1	144.97N

** VENTURA **

	N6MBR-1	145.07B
	N6MBR-6	145.07N
	W8AKF-1	145.03B
	WK6K-1	145.63B
AKFBBS	W8AKF-12	145.03B
AKFBBS	W8AKF-12	145.05B
AKFNDE	W8AKF-10	145.03N
AKFNDE	W8AKF-10	145.05N
CAMA	K6IYK-11	145.05N
CONEJO	W8AKF-15	144.99N
CONEJO	W8AKF-15	145.03N
HFBBS	W8AKF	145.09B
HFNODE	W8AKF-8	145.03N
NTSBBS	W8AKF-9	145.03B
SBARB	W8AKF-6	145.03N
SBARB	W8AKF-6	145.09N
VANYS	W8AKF-7	145.03N

** ARIZONA **

#QRTZ	WA6OFT-4	145.07N
BULL	W6MCV-1	145.01N
BULL	W6MCV-3	145.03A
HAVASU	KE6GX-5	145.05N
HVSU	WA6OFT-6	145.07N
KGM	KB7AG-1	145.01N
KGM3	WB7BNI-2	145.03N
PRDM	WA6OFT-10	145.07N
PRKR	WA6OFT-3	145.07N
QRTZ	WA6OFT-15	145.07N
WENDY	KA6HMG	145.07A
YUMA	K7DOB-5	145.05N

** NEVADA **

LAS	K7WS-1	145.01N
LVBBS	KG7LJ	145.01B
LVBBS	KG7LJ	145.05B
LVNODE	KG7LJ-3	145.01N
LVNODE	KG7LJ-3	145.05N
LVV	WI7D-1	145.01N
VEGAS	WA7HXO-1	145.05N

** OREGON **

	KA7FHA	145.53B
	KI7AE	145.77B
	WB7VMS	145.07B
ASH	KA0DFN	145.01B
MURPHY	WB7VMS	145.01B

ALIAS	CALL	FREQ	COVERAGE OR PURPOSE			
	WB6AKF	3.622	HF MBO GATEWAY	NEWBURY PARK	900	T
	WB6AKF					
	WB6ZVW					
	N6DA					
	WB6AKF					
	WB6AKF					
KERN	KM6WJ					
	KC6TSH					
KAYJOS	N6JYA-2					
KAYNCO	N6JYA-1					
	WX7K-6					
	N6MN					
MNTBLC	KB6RAA-1					
KA6BCS	KD6VAA					
	WB6AKF-15					
KCMK	KF6AT					
	WB6AKF					
	N6HPJ-4					
	KB6TDH-2	28.103	-->145.07	MODESTO	175	X
	KC6TDH-7	28.103	MODESTO AREA	MODESTO	175	N
OSO	WD6EJF-2	28.103		MT. OSO	3300	D
SARA	N6KMR-7	28.103		CERES		X
UNOEBS	K6UNO	28.105		DIAMOND BAR		B
	WB6AKF	28.122	HF MBO GATEWAY	NEWBURY PARK	900	S
ANTBLO	KD6RAA-1			MONT		
KA6BCS	KD6RAA					
LASOV	KT6M-10					
	KB7LJ-3	51.120	AZ/NV/CA/CO	LAS VEGAS		N
ANGEL	K7WS-12	51.120	AZ/NV/CA/CO	ANGEL		N
#GFRN	WB6YNH-4	51.120	BACKBONE	PALOS VERDES		GX
#HVSUN	KE6BX-4	51.120	BACKBONE	LAKE HAVASU CITY	1000	V
#KGM6M	WB7BNI-15	51.[illegible]	AZ/CA/NV	KINGMAN		N
#LAS6M	K7WS-11	51.[illegible]	AZ/NV/CA/CO	LAS VEGAS		N
#ORTZ	WA6OFT-4	51.[illegible]	BACKBONE	QUARTZSITE	3000	K
		51.[illegible]	RIVERSIDE CO (RACES)	SIM FOREST	5300	NK
TWRS	WB7BNI-6	51.120	BACKBONE	TOWERS MT		P

ALIAS CALL FREQ. COVERAGE OR PURPOSE

Please send all corrections to Bob,

#TCPIP	WD6EHR-7	144.760	[illegible]	[illegible]	[illegible]
CVNODE	KO6Y-3	144.760	[illegible]	[illegible]	[illegible]
	WX6I-6	144.710	[illegible]		
PA8911	XGXA	144.910	[illegible]	[illegible]	
PLO	N6RVE-7	144.710	ALTERNATE	[illegible]	[illegible]
	KI6YK	144.990	SAN RAMON VALLEY	[illegible]	700
	WE6BX	144.930	[illegible]	[illegible]	
	N6PEV-1	144.990	[illegible]	[illegible]	
[illegible]	KI6CY-1	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	BF.MONT BAY-->223.60	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	KI6WE	144.970			
	WD6CMJ	144.970	[illegible]		
	WB6EAV-1	144.990	[illegible]	[illegible]	
	K6LY	144.970			
	WD6XZ-1	144.970			
	KK6BZ-2	144.970	CONCORD - [illegible]		
#LSBBS	N6LDL	144.970	SANTA C[illegible]	[illegible]	
#LGNOD	N6LDL-1	144.970	SANTA C[illegible]	[illegible]	
APPLE	WA6ETH-2	144.97[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
DITO	KI6V-1	[illegible]	[illegible]	[illegible]	
GOME	WA6BTH	144.970	EL DORADO CO.	[illegible]	
GKIP	KC6JEM-1	144.970	ORINDA-LAFAYETTE	[illegible]	
GONORA	KK6ZZ-1	[illegible]	[illegible]	[illegible]	
TINO	[illegible]	[illegible]	[illegible]	AREA	[illegible]
[illegible]	WA6VFO	[illegible]	[illegible]	AREA	C[illegible]
VOL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	KA6FUB	[illegible]	[illegible]	C	M[illegible]
	N6OA	144.990			L[illegible]
	W6SF	144.990	SAN JOAQUIN CO.		S[illegible]
	N6TYN	144.990	SF BAY AREA		SAN MATEO 50 D
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	WB6ZVW	144.990	SO. SANTA CLARA VALLEY		MORGAN HILL N
#RWCGD	WA6DRZ-6	144.990	--> DC & 36M APLINK		REDWOOD CITY 450 D
#SFBBS	W6PW-3	144.990	SAN FRANCISCO BAY AREA		SAN FRANCISCO 515 D
AMCYN	WZ6X-2	144.990			AMERICAN CANYON N
CONEJO	WB6KF-15	144.990			BRIMES CYN 1400 D
GARLIC	AA4RE-2	144.990	GILROY/MORGAN HILL		GILROY 775 D
GVFBBS	AA4RE-1	144.990	GILROY/MORGAN HILL		GILRO[illegible]
KBFB	KA6FUB-1	144.990	EAST/CENT CONTRA COSTA		KRESGR PEAK
LEM	N6NHZ-1	144.990			LEMOORE
NAVY	W6PW-6	144.990	SAN FRANCISCO BAY AREA		OAKLAND
PINGRV	KF6BY-1	144.990	[illegible]		PINE GROVE
RWC	WA9DRZ-7	144.970	[illegible]		REDWOOD CITY
SF	WB9LOZ-2	144.990	SAN FRANCISCO BAY AREA		SAN FRANCISCO
SFW	W6PW-1	144.990	SAN FRANCISCO BAY AREA		SAN FRANCISCO
SON	KK6ZZ-C	144.990			SONORA
SSF2	KA6EYH-2	144.990	SAN FRANCISCO BAY AREA		SAN BRUNO MT.
TORBS	WB6KF-4	144.990	BBS FWDING		CONEJO VALLEY
YCBBS	KE6LW-1	144.990	NORTH SACTO VALLEY		YUBA CITY
YUBA	KE6LW-2	144.990	N. VLY WOS ACCESS NODE		SUTTER BUTTES

ALIAS	CALL	[illegible]	[illegible]	INFOSF	[illegible]

[illegible]

	[illegible]	145.010			[illegible]
[illegible]	[illegible]	145.010			[illegible]

	WAMCV-1	145.010		[illegible]		
	WA6RDL	145.010	[illegible]	[illegible]		
	[illegible]	145.010	AZ/[illegible]/NV/[illegible]	[illegible]		
	K7WS-1	145.010	AZ/NV[illegible]			
	[illegible]	145.010		[illegible]	[illegible]	
	[illegible]	145.010	AZ/NV/CA	LAS VEGAS		
	KD6NZV-1	14[illegible].010	SAN DIEGO [illegible]	SAN DIEGO	[illegible]	
	AA6WLV-1	145.010	SAN DIEGO CO.	MT OTAY	3500	N
	[illegible]	145.010	[illegible]/NA/A7	PALMDALE	2550	[illegible]
	[illegible]-5	145.010	ANTELOPE VALLEY	PALMDALE	210	N
	[illegible]	145.010	EAST SAN DIEGO	SANTEE	500	[illegible]
	AA6GN	145.010	SAN DIEGO CO.	SANTEE	500	B
	WA6RDF-1	145.010	SACRAMENTO VALLEY LAN	MT VACA	[illegible]	N
	WF6O	145.030	ORANGE CO.	ANAHEIM		B
	N6FRW-3	145.030	RIVERSIDE CO (RACES)	[illegible]		
	[illegible]	145.030	SAN BERNARDINO VALLEY	SAN BERNARDINO	[illegible]	
	W8AKF-1	145.[illegible]	[illegible]	[illegible]		
#RKYMB	N6RKY-2	145.030	ORANGE CO.	ORANGE		B
#AFNDE	W8AKF-10	145.030		THOUSAND OAKS	950	N
[illegible]	[illegible]	145.030		[illegible]HEAD CITY		FN
[illegible]	[illegible]	145.[illegible]		GRIMES CYN	1400	
#-NODE	W8A[illegible]-6	145.[illegible]		[illegible] VALLEY	[illegible]	
	[illegible]	145.[illegible]	PARAMOUNT [illegible]	PARAMOUNT		B
[illegible]	K[illegible]	145.[illegible]	PARAMOUNT [illegible]	[illegible]		
				KINGMAN		N
[illegible]	K6VE-5	[illegible]	[illegible]	MT WASHINGTON	[illegible]	
LANCDE	K6VE-10	145.030	LOS ANGELES AREA	MT WASHIN[illegible]		
MNTBLO	K36RAA-1	145.030		MONTEBE[illegible]		
NTSBBS	W8AKF-9	145.030	USER BULLETIN/F/T BBS	NEWBURY PARK	[illegible]	
RAABBS	K36RAA	145.030		MONTEBELLO		[illegible]
RIAT	KB6BVT-3	145.030		RIALTO		
[illegible]	N6KZB-7	145.030	RIVERSIDE CO (RACES)	[illegible]	5[illegible]	[illegible]
RKYBBS	N6RKY	145.030	ORANGE CO.	ORANGE		B
[illegible]	W8AKF-6	145.030		NEWBURY PARK	900	N
VANYS	W8AKF-7	145.[illegible]		VAN NUYS		
	WW6L-1	145.050	NO. SLO CO.	ATASCADERO	777	[illegible]
	N6YN	145.050		WESTCHESTER		B
	W6IN	145.050	SAN FERNANDO DCS/RACES	SAN FERNANDO	950	[illegible]
	WF6O	145.050	ORANGE CO.	ANAHEIM		B
	KD7XG-1	145.050	CORONA (RACES)	CORONA		B

ALIAS	CALL	FREQ.	COVERAGE OR PURPOSE	LOCATION		

Please send all corrections to Bob, AA6UP @ K6RAU.#N[illegible]

	N6ADV	145.050	BARSTOW - VICTORVILLE	YERMO		B
	WA6PEZ-1	145.050	HIGH DESERT	BARSTOW	2500	N
	AA6QD-2	145.050	SANTA YNEZ VALLEY	SOLVANG	500	B
	N6AZP	145.050	SANTA BARBARA CO.	LOMPOC		B
	[illegible]	145.050	BBS FWDING	NEWBURY PARK	900	B
	[illegible]	145.050		THOUSAND OAKS	950	N
	[illegible]	[illegible]0	HIGH DESERT [44.18.0.9]	BARSTOW	2500	NT
	[illegible]	[illegible]	[illegible]RAL VENTURA CO.	CAMARILLO (RSR)	300	B

145.050 SAN DIEGO CO.

145.070 SAN MATEO CO./DUMAGT

145.070

145.070

145.070

145.070

145.070 SOUTH ORANGE CO.

145.070 RIVERSIDE CO (RACES)

145.070 PALM DESERT (RACES)

145.070 RIVERSIDE PEDC (RACES)

145.070 INDIO AEDC (RACES)

145.070 PERRIS DSF-ARU (RACES)

VENTURA CO.

145.070 VENTURA CO.

145.070

145.070

145.070

145.070 RIVERSIDE CO (RACES)

145.070 W. LA/SANTA MONIC

CALIFORNIA PACKET RESOURCES BY FREQUENCY

FREQ. COVERAGE OR PURPOSE LOCATION

Please send all corrections to Bob, WA6UP @ KA6AU.#NCCA

	REQ.	COVERAGE OR PURPOSE	LOCATION	ELEV	ERP
	145.690	TEMECULA (RACES)	TEMECULA		S
	145.690	HEMET VALLEY (RACES)	HEMET		S
	145.690	RIVERSIDE CO (RACES)	HEMET	1550	RIV
	145.710	SANTA CLARA VALLEY	LOS GATOS	400	SC
	145.710	SANTA CLARA VALLEY	LOS GATOS	100	SC
	145.710	[illegible] 20 & 30M AMTCR	REDWOOD CITY	450	RDX
-2	145.710	SAN MATEO CO.	MENLO PARK		SC
7	145.710	---> SBAY LAN	REDWOOD CITY	150	DC
	145.730	LAFAYETTE/ORINDA	ORINDA	475	B
			PITTSBURG		C
	145.730	FRESNO/MADERA CO.			D
	[illegible] .30	HUMBOLT CO./REDWOOD EMP.	EUREKA		
1	145.730		REDWOOD CITY	460	N
		SONOMA CO.	CETATI		F
	145.730		BOULDER CREEK		D
			PINNERY PARK	100	PM
			SAN JOSE	20	B
			SAN JOSE	700	N
			PT. ARENA	850	N
			BOULDER CREEK		

CALIFORNIA PACKET RESOURCES BY FREQUENCY

COVERAGE OR PURPOSE

all corrections to Bob, W6UP @

[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	223.[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	S. LAKE TAHOE	
	[illegible]		SACRAMENTO	
	[illegible]	[illegible] VALLEY	GLENDORA	
		SAN GABRIEL VALLEY	GLENDORA	400
	223.600	NETWORK ACCESS	JOHNSTONE PK	7400
		SAN DIEGO NODE SWITCH	SAN DIEGO	300
	223.[illegible]	SAN DIEGO BBS	SAN DIEGO	
		[illegible] LAN GATEWAY	MT VACA	2800
	.620	SOUTH BAY	SUNNYVALE	100
	223.620		PALO ALTO, SARATOGA	
		SANTA CLARA VALLEY	LOS GATOS	[illegible]
K[illegible]		ALMADEN VALLEY AND AREA	SAN JOSE	[illegible]
N6QM	223.620	SBAY LAN GATEWAY	FREMONT	
		S.C. CO. EMERGENCY OPS		
	223.680		PALO ALTO	

CALIFORNIA PACKET RESOURCES BY FREQUENCY 1 Ja[illegible] 19[illegible]

[illegible]	FREQ.	COVERAGE OR PURPOSE	LOCATION	[illegible]
	22[illegible].700	-->NBAY LAN	EUREKA	
	223.[illegible]	-->NX[illegible]	[illegible]	
	[illegible]		[illegible]	
	223.700	BBS FWDING	[illegible]	
	[illegible]	BBS [illegible]	SANTA CRUZ	
	[illegible]	[illegible] FWD TO WX[illegible]	THE ROCK	
	223.700		BEN LOMOND	
	[illegible]0	REDWOOD EMP/HUMBOLDT CO.	EUREKA	
			SANTA CRUZ	
		REDWOODS BACKBONE	PETALUMA	
WB6[illegible]-1	223.700		SOLVES	
		NBY[illegible]AY LAN GATEWAY	FELTON	
		SF BAY AREA	BERKELEY	650
KA6US-1	[illegible]	NORTH BAY	RICHMOND	
	[illegible]	OF BAY AREA	RICHMOND	
KA6EYH	223.720	-->NBAY	PACIFICA	
KA6JLT-2	223.720		MENLO PARK	
		NBAY BBS LAN	[illegible]	1775
	223.720	NBAY LAN GATEWAY	[illegible]	
	223.720	NBAY LAN	ROHNERT PARK	[illegible]
WA6DRZ-6	223.720	--> NBAY LAN	REDWOOD CITY	45[illegible]
	223.720	SAN FRANCISCO BAY AREA	SAN FRANCISCO	[illegible]
	223.720	MAIL FWD TO NBAY LAN	ROHNERT PARK	10[illegible]
WA6DRZ-7	223.720	--> SBAY LAN	REDWOOD CITY	[illegible]
	223.720	SAN FRANCISCO BAY AREA	SAN FRANCISCO	
		SOUTH BAY		[illegible]
	433.410	CNTL. CONTRA COSTA CO.	MARTINEZ	10[illegible]
			[illegible]	
	433.4[illegible]0	BUTTE CO LINK TO KRES	ST JOHN MT	[illegible]
	433.410	BBS FORWARDING-NORTH	[illegible] PEAK	
	433.41[illegible]	[illegible]	PALMDALE	[illegible]
			SANTEE	

	KA7Z-11	436.950 SANTA YNEZ PEAK	SANTA BARBARA
		438.950 9600 BAUD LINK	SANTA BARBARA
		438.950 9600 BAUD TESTING	CAMARILLO (ASA)
		439.000	ORANGE COUNTY
	N6KZE	439.000 RIVERSIDE CO	RIVERSIDE
		439.000 RIVERSIDE CO (RACES	HEAPS PEAK
	WB6NKT-12	439.000	
	N6AKF-10	439.000	
	KB6ZES	439.000 PARAMOUNT AREA	
	KB6ZES-1	439.000 PARAMOUNT AREA	
	KB6UVI-4	439.000	
	N6AKF-7	439.000	
		439.025 PALOS VERDES	
	WD6EAP	439.025	
	WB6YMH-4	439.025 PALOS VERDES	
		439.025	

ALIAS CALL

Corrections to 2nd

		437.[illegible]	
	KA6VE-5	439.025	
		439.0[illegible]	
	WB6AKF-9	439.0[illegible]	
NZN	KC6NZN-1		
YEV	AA6QN-1		
BF656B	AA6QN		
PALM		900/FWD/WEST 4KA/67	
BR-			
	KD6YZ-1		
	WA6?	CLARA VALLEY	
		441.500 DNS/FD 1.2K	YOSEMITE PARK
		441.500 --> BRAY LA	BERNUDA
		441.500 MEADOWOOD LAN	[illegible]
	N7EOF-4	900/MTN LINK	PETALUMA
		441.500 CHULA VISTA NODE SWITCH	CHULA VI[illegible]
		441.500 SACTO VLY	DIXON
		441.500 LA CITY EMPL RACES 886	EAGLE ROCK
	KR6NTF-11	441.500 FWD PORT / NODE	EAGLE ROCK
		441.500 RF LA GATE TO 1.2 DCA	EAGLE ROCK
		441.500 RPS USER/FORWARDING	FREMONT
	WA6MY-2	441.500 SOUTH BF BAY AREA	FREMONT
		441.500 LOS ANGELES AREA	MT WASHINGTON
	K6VE-10	441.500 LOS ANGELES AREA	MT WASHINGTON
		441.500 SAN DIEGO CO.	PT. LOMA
		441.500 MONTEREY BAY	SALINAS
		441.500 SAN DIEGO NODE SWITCH	SAN DIEGO

WESTNET.BBS

LINKED MAILBOXES PARTICIPATING IN WESTNET
BY CALLSIGN

AS OF: 30 January 1993

Amateur Packet Radio MailBoxes in the Western United States are linked and provide automatic message forwarding. Message traffic entered at any of the MailBoxes listed below will be forwarded within this system automatically, and traffic destined for locations outside of WESTNET will be processed to the nearest GateWay station for proper forwarding.

CALLSIGN	LOCATION	HOME FREQ	ACCESS NODE	HUB BBS	OTHER PORTS / LINKING GENERAL NOTES
** -A-					
N6ADV	Yermo,CA	145.05		KC6LHA	LINKED VIA KB6GVT/WA6PEZ
KI7AE	Klamath Falls,OR	0.00			LINKED TO WX3K
KA7AGH	Gresham,OR	145.07			
NB7AHN	Sutherlin,OR	145.55			
N8AKF	Newbury Park,CA	145.09	VNTURA	K6IYK	*NF* 223.58B,3.635B,7.1025B, 7.1082B,10.147B,14.098B, 21.097B,28.122B
N8AKF-1	Newbury Park,CA	7.10 @			*NF*
N8AKF-12	Newbury Park,CA	145.05	AKFBBS	K6IYK	145.03,18.105
N8AKF-13	Newbury Park,CA	0.00	VNTURA	K6IYK	*NF* 223.58B
N8AKF-3	Newbury Park,CA	0.00	VNTURA	K6IYK	223.58B
N8AKF-9	Newbury Park,CA	145.03	VNTURA	K6IYK	223.58B.439.025
NA7ARI	Salem,OR	144.97			10.147, 440.975
[illegible]ARS	Albquerque,NM	145.01	ABQ4	******	145.05,145.07,446.80
[illegible]CRY-1	Sunnyvale,CA	144.93		N6DMY	223.62B,433.37
KD6AXC	Pinion Hills,CA	145.05		KC6LHA	223.58B LINKED VIA WA6PEZ
N7AZF	Morro Bay,CA	145.09	AZFBBS	K6IYK	145.03B 145.05B LINKED VIA K6TZ/WW6L
** -B-					
K7BUC	Phoenix,AZ	145.11 -	PHX	N7MRP	APLINK, LINKED VIA KB7TV
K7BUC	Phoenix,AZ	145.11 -	PHX	N7MRP	APLINK, LINKED VIA KB7TV
** -C-					
KC7CG	Tucson,AZ	145.01	TUS	N7MRP	145.05 LINKED VIA KB7TV. LINK INTO NM
KE5CI	Silver City,NM	145.01	SVC		LINKED VIA K5WPH, LINK TO AZ
WD6CMU	Richmond,CA	144.97	#NBAY1	******	223.72B NBAY HUB BBS
W6CUS-1	Richmond,CA	145.09		WD6CMU	223.72B
N1CWP	Medford,OR	145.07			
KBOCZV	GrandJunction,CO	0.00	BAXTER		
** -D-					
WI7D	Las Vegas,NV	0.00		KG7LJ	APLINK
KB7DBD	Sandy,OR	145.05			145.65, 18.105, 440.975
W7DCR	LaPine,OR	145.03			14.072 APLINK
KA0DFN	Ashland,OR	145.07			220.95
K5DI	Las Cruces,NM	145.07		WB5NQC	447.75
[illegible]DRZ-6	Peewood City,CA	144.99 B	#NBAY1	WD6CMU	*NF* 441.5B(-4),223.72B(-2), 20/30M AMTOR GATE,145.71@9600
N7DXT	Eugene,OR	145.59			
** -E-					

WESTNET.BBS

LINKED MAILBOXES PARTICIPATING IN WESTNET
BY CALLSIGN

AS OF: 30 January 1993

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CALLSIGN	LOCATION	HOME FREQ		ACCESS NODE	HUB BBS	OTHER PORTS / LINKING GENERAL NOTES
** -A-						
N6ADV	Yermo,CA	145.05			KC6LHA	LINKED VIA KB6GVT/WA6PEZ
KI7AE	Klamath Falls,OR	0.00				LINKED TO WX3K
KA7AGH	Gresham,OR	145.07				
WB7AHN	Sutherlin,OR	145.55				
W8AKF	Newbury Park,CA	145.09		VNTURA	K6IYK	*NF* 223.580,3.635B,7.1025B, 7.1082B,10.147B,14.098B, 21.097B,28.122B
W8AKF-1	Newbury Park,CA	7.10	B			*NF*
W8AKF-12	Newbury Park,CA	145.05		AKFBBS	K6IYK	145.03,18.105
W8AKF-13	Newbury Park,CA	0.00		VNTURA	K6IYK	*NF* 223.58E
W8AKF-3	Newbury Park,CA	0.00		VNTURA	K6IYK	223.58E
W8AKF-9	Newbury Park,CA	145.01		VNTURA	K6IYK	223.580,439.025
WA7ARI	Salem,OR	144.97				10.147, 440.975
KC5ARS	Albquerque,NM	145.01		ABQ4	******	145.05,145.07,446.80
N6ARY-1	Sunnyvale,CA	144.93			N6OMY	223.62B,433.37
KD6AXC	Pinion Hills,CA	145.05			KC6LHA	223.58B LINKED VIA WA6PEZ
W7AZF	Morro Bay,CA	145.09		AZFBBS	K6IYK	145.03B 145.05B LINKED VIA K6TI/WW6L
** -B-						
K7BUC	Phoenix,AZ	145.11	-	PHX	N7MRP	APLINK, LINKED VIA KB7TV
K7BUC	Phoenix,AZ	145.11	-	PHX	N7MRP	APLINK, LINKED VIA KB7TV
** -C-						
KC7CG	Tucson,AZ	145.01		TUS	N7MRP	145.05 LINKED VIA KB7TV, LINK INTO NM
KE5CI	Silver City,NM	145.01		SVC		LINKED VIA K5WPH, LINK TO AZ
WD6CMU	Richmond,CA	144.97		#NBAY1	******	223.72B NBAY HUB BBS
W6CUS-1	Richmond,CA	145.09			WD6CMU	223.72B
N1CWP	Medford,OR	145.07				
KB0CZV	GrandJunction,CO	0.00		BAXTER		
** -D-						
WI7D	Las Vegas,NV	0.00			KG7LJ	APLINK
KB7DBD	Sandy,OR	145.05				145.65, 18.105, 440.975
W7DCR	LaPine,OR	145.01				14.072 APLINK
KA6DFN	Ashland,OR	145.07				220.95
KC5DI	Las Cruces,NM	145.07			WB5NQC	447.75
N6DRZ-6	Redwood City,CA	144.99	B	#NBAY1	WD6CMU	*NF* 441.5B(-4),223.72B(-2), 20/30M AMTOR GATE,145.71@9600
N7DXT	Eugene,OR	145.59				
** -E-						

N6ECF	Reading,CA	145.09		KA6FUE	223.42B
KG6EE	Santa Cruz,CA	145.07	SCZNOD	N6IYA	223.70B LINKED TO KI6EH
N6EEG	Berkeley,CA	144.97		WD6CMU	10.147B,223.72B
KI6EH	Santa Cruz,CA	145.07		N6IYA	223.70 LINKED VIA KG6EE, Santa Cruz Co OES
WEES-1	El Paso,TX	145.05	ELP	WB5NQC	223.40 LINKED VIA K5DI, NM REGIONAL WP SERVER
WA6EWV-1	So. Lake Tahoe,CA	144.97		WA6RDH	223.60B
KA6EYH	Pacifica,CA	145.07	#NBAY1	WD6CMU	223.72 441.5
** -F-					
WG5F	Midland,TX	145.01	MAF		LINKED VIA N5IGO
W6FNO-10	Glendora,CA	223.60	JOHNPK	K6VE	223.54
KB7FRV	Prescott,AZ	145.07	NAZPAC	KA6HMG	
KA6FUB	Martinez,CA	144.99	#KREG3	******	433.41B, 441.5 EBAY HUB BBS
KJ6FY-1	Benicia,CA	144.93	SOLANO	KA6FUB	223.54B
** -G-					
W8GEC	Boulder Creek,CA	145.73		N6IYA	223.70B LINKED TO N6MPW
WA7GFP	Portland,OR	145.01			51.7, 145.51
N7GLL	Paradise Valley,AZ	145.05	TUS	N7MRP	
KOGUZ	Glenwood Spr,CO	145.01	GWS		LINKED VIA KB9CZV
KB6GVT	Rialto,CA	145.05	#RIM96	KC6LHA	145.61, 439.06, 223.56
** -H-					
WA6HAM	Pittsburg,CA	145.73		KA6FUB	433.41B
W9MGI	Gilroy,CA	0.00	GARLIC	AA4RE	*NF* SATGATE
KM6HK-1	Madera,CA	145.07	KERN3	******	223.56B SJV HUB BBS
KA6HMG	Parker,AZ	145.07	QRTZ	******	AZ HUB, LINKED TO KG7Y/W6MCV/KG7LJ
** -I-					
N6IA	Las Vegas,NV	0.00		KG7LJ	*NF* APLink (AMTOR)
KB5IC	San Jose,CA	145.73		N6QMY	223.62B, LINKED TO WA6LYZ
N6IIU-1	Palo Alto,CA	145.07		N6QMY	223.62B, 223.68
W6IN	San Fernando,CA	145.05		K6VE	223.54B LINKED VIA WB6WFH ***DECORDINATION PENDING***
W7IO	Phoenix,AZ	145.05	AZCTL	N7MRP	Central AZ ARC
KB6IRS	Soquel,CA	145.09		N6IYA	223.70 14.107
N6IYA-2	Felton,CA	145.09	MRYNOD	******	223.70, 441.5 MRYBAY HUB BBS
K6IYK-4	Camarillo, CA	145.05	CAMA	******	223.56, 1.2GHz, WP REGIONAL SERVER, WESTNET COORDINATOR
** -J-					
WG7J	Corvalis,OR	145.55			
KB6JES-1	Paramount,CA	145.03	#RIM96	******	223.58B, 439.05
W7JHX	Tucson,AZ	145.15 -	TUS	N7MRP	30M HF GATE TO CO, LINKED VIA KC7CG
KA6JLT-2	Menlo Park,CA	145.73		WD6CMU	223.72B, 145.71@9600
KA5JNJ	Farmington,NM	145.01	ABQW	WB2ARS	
W6JW	Santa Clarita,CA	145.07		K6VE	223.58B
** -K-					
NR7K	St. George,UT	145.01			LINKED TO KG7LJ
WX3K	Rohnert Park,CA	145.73	#SON2	******	223.72B, 223.70B, 441.50, NCOAST HUB BBS
KC7HN	Incline Village,NV	0.00			LINKED VIA KG7LJ
KC7MJ	Pendleton,OR	144.95			10.147, 144.97
WA6KTP-2	Manteca,CA	145.79	#MRCED	******	223.56B, 433.41B, SJV HUB BBS
N6KZB	Riverside,CA	145.07	#RIM96	KC6LHA	OUT OF SERVICE TILL 2/93 - MOVING

** -_-					
WW6L	Atascadero,CA	145.05		K6IYK	LINKED TO K6TZ/AA4RE
N6LDL	Los Gatos,CA	144.97	#LGNOD	N6OMY	223.62B, 145.71@9600
NOLEU	Steamboat Spr,CO	145.01	STMBT		440.05 LINKED VIA N7MLR
[illegible]6LHA	San Bernardino,CA	145.63	#HP220	******	223.58B, 145.03, IEBBS HUB
[illegible]40	Santa Fe,NM	145.01			14.107, LINKED VIA W8AKF
[illegible]7LJ	Las Vegas,NV	145.01	LAS		145.05 LINK TO K6IYK/ W6MCV/NR7K/KA6HMG
KE6LW-1	Yuba City,CA	144.99	#YCNOD	WA6RDH	441.50
K6LY	Monterey,CA	144.97		N6IYA	223.70B
WB6LYE	Eureka,CA	145.73		WX3K	223.70B LINKED TO K7WWA
WA6LYZ	Saratoga,CA	0.00		N6OMY	*NF* 223.62B 441.5B, SBAY LINK
** -M-					
N6MBR-1	Thousand Oaks,CA	145.07	CV	K6IYK	223.58 LINKED VIA W8AKF
K3MC	Sunnyvale,CA	145.09		N6OMY	BBS>SMTP GATE TO 145.75
W7MCO	Duncan,AZ	0.00	#PINAL	N7MRP	LINK TO NM
W6MCV	Bullhead City,AZ	145.03	KGM3		HF(B), LINKED VIA KA6HMG
N7MLR	Provo,UT	145.01	DINA		440.05 LINKED VIA NV7O, WX7Y, KG7LJ
N6MPW	Ben Lomond,CA	145.79		N6IYA	21.111B, 223.70B
N7MRP	Phoenix,AZ	145.11	- SWX	******	LINKED TO KG7LJ/KB7TV
WA7MXZ	Logan,UT	145.01	LGU	N7MLR	
** -N-					
KE6NJF	Eagle Rock,CA	0.00		K6VE	441.5,223.54 LINKED VIA K6VE/1.2GHZ LINK TO K6CPT
WB5NGC	Ruidoso,NM	145.01	BUCK2	******	CENTRAL NM LINK
W6[illegible]NE-1	N. Highlands,CA	145.09		WA6RDH	441.50, BBS>SMTP GATE TO 144.93
KD7NX	Holliday,UT	145.05	SLC5	N7MLR	
KC6NZN	San Diego,CA	145.05	NZN	******	223.54, LINKED VIA K6IYK, 145.01,441.5,439.025
** -O-					
NV7O	Paragonah,UT	145.01	MLF	N7MLR	
WF6O	Anaheim,CA	145.05	OCEAN	K6VE	223.56, LINKED TO KK6SR
N6OA	Lemoore,CA	144.99		WA6KTK	223.56B,10.147B,21.097B LINKED TO K6RAU
N7OJV	Ely,NV	145.01	ELY		LINKED TO N6RQY/KC6VZZ/KG7LJ
N6OKS	Hemet,CA	145.69	PNE220	KC6LHA	223.56 LINKED VIA KC6LHA
KC6OWI	Apple Valley,CA	145.63		KC6LHA	223.58 LINKED VIA WA6PEZ
KC6OXK-2	Los Angeles,CA	145.65	LANODE	K6VE	441.5, 38.190
** -P-					
NJ7P	Sierra Vista,AZ	145.15	- TUS	N7MRP	LINKED VIA KC7CG
NR6P-1	Palm Desert,CA	145.07		KC6LHA	*NF* NO BULLS, RACES
WA6PEZ	Barstow,CA	145.05	#HP220	KC6LHA	223.58B LINKED VIA KB6BVT
KC6PJW	Cotati,CA	145.73		WX3K	441.50B
W6PW-3	San Francisco,CA	144.99	SF	WD6CMU	223.72
** -Q-					
WA7QCF	Klamath Falls,OR	145.77			
AA6QD-2	Solvang,CA	145.05		K6IYK	223.58B PHONE PORT 805/686-1891 LINKED VIA K6TZ
[illegible]5QE	Los Osos,CA	0.00		K6IYK	223.58B SATGATE LINKED VIA WD6Z-2
W6QFK-2	Temple City,CA	145.65		K6VE	LINKED VIA W6FNO
[illegible]6QMV-1	Fremont,CA	145.79	#SBAY3	******	145.09B 223.62B 441.5 SBAY HUB BBS

[illegible]	Santee,CA	145.01	SEE	KC6NZN	439.025B SATGATE
[illegible]	Orinda,CA	145.73		KA6FUB	223.54B, 51.14B
**-P-					
[illegible]	Albquerque,NM	145.01	ABQ4	WB2ARS	14.111(B)
[illegible]	Montebello,CA	145.03	MNTBLO	K6VE	223.54B, 14.113B, 28.160
[illegible]	Merced,CA	145.09		WA6KTK	223.56B NCXPN BBS COORDINATOR
WA6RDH	Dixon,CA	145.01	#VACA3	******	223.54B 223.60B 441.5 SACVAL HUB BBS
AA4RE-1	Gilroy,CA	144.99	GARLIC	******	223.58B "OTHER" HUB BBS
[illegible]	Woodland,WA	144.91		WORLI	223.48 14.107B LINKED TO WA7SJN (Ex: KB6GOZ)
WORLI-2	West Linn,OR	144.91			14.098B, 145.51, 220.95, 440.975 LINKED VIA W8AKF
N6PDY	Elko,NV	145.01	ELKO		LINKED TO N7OJV
[illegible]	Santa Fe,NM	145.05		WB2ARS	446.80
**-S-					
[illegible]	Page,AZ	145.01	NAVAJO		LINKED VIA KG7LJ
N7SEE	Great Falls,MT	145.01			LINKED VIA N7HHU
W6SF	Stockton,CA	144.99		KA6FUB	223.54B
WA7SHP	Salem,OR	145.65			440.975
WA7SJN	Kalama,WA	145.09			
KA5SPY	Hobbs,NM	145.01	HOB		LINKED VIA N5IGO
[illegible]	Huntington Bch,CA	145.63	SWBBS	K6VE	223.56
K7SWT	Vernal,UT	145.01	DINA		LINKED VIA N7MLR (MAY QRT?)
[illegible]	Sonora,CA	144.97		WA6KTK	223.56B LINKED TO K6RAU
**-T-					
[illegible]	Layton,UT	145.07	DAV	N7MLR	
[illegible]	Scottsdale,AZ	145.05	AZCTL	N7MRP	TCP/IP ONLY
[illegible]	Salt Lake,UT	145.01	SNOW		LINKED VIA K7PYK & KG7LJ
KE7TV	Awahtukee,AZ	145.11 -	TUS	N7MRP	145.15- LINKS TO KC7CG
WA6TVG	Eureka,CA	145.01	EURBBS		LINKED VIA WB7VMS (WAS WB6LYE)
K6TZ	SantaBarbara,CA	145.07	#CAPPV	K6IYK	223.56(-10)
**-U-					
K7UKP	Astoria,OR	144.93			
K6UNQ	Diamond Bar,CA	145.05	UNOBBS	K6VE	28.105 LINKED VIA W6FNO
**-V-					
[illegible]	Payson,UT	145.03	#SLC44		
W5VEO	Peoria,AZ	145.05	AZCTL	N7MRP	AMTOR HUB
[illegible]	Temecula,CA	145.03	TEMEKU	KC6NZN	223.54
K6VE-5	Los Angeles,CA	145.01	LABBS	KB6JES	224.54,446.50B LA MAN HUB
W6VIO-1	Pasadena,CA	145.09	JPLARC	K6VE	223.54
WB7VMS	Grants Pass,OR	145.01	VMSMB		145.07, 220.95
[illegible]	Newport,OR	145.09			
KC6VZI-2	Bishop,CA	145.01	BIH		LINKED VIA WA6YBN/KG7LJ
**-W-					
[illegible]	Pleasant Hill,CA	144.97		KA6FUB	223.54B
WB6WFP	Chatsworth,CA	145.63	SFVBBS	K6VE	223.54
[illegible]	El Paso,TX	145.07	WTNM	K5DI	223.40
[illegible]	Lake Isabella,CA	145.79	#KERN4	K6IYK	7.108B, 28.190B, 223.56E **SOCA LINK DOWN 12/92**
N7WVZ	Elko,NV	145.01			LINKED VIA N7OJV
[illegible]	Willits,CA	145.79		WX3K	223.706
**-X-					

KD7XG	Corona,CA	14.10 9		KC6LHA	*NF* 223.56E
KD7XG-1	Corona,CA	145.05		KC6LHA	*NF* 223.56E(-2
KG6XX-1	Carmichael,CA	145.07		WA6RDH	441.50 LINKED TO WA6NWE
KD6XZ-1	Sacramento,CA	144.97	#SARCR	WA6RDH	223.60B, 441.5

** -Y-

[illegible]Y	Mesa,AZ	145.39	#SMITH	N7MRP	LINKED VIA KA6HMG
WX7Y	Castle Dale,UT	145.01	PRICE3		
WA6YBN	Ridgecrest,CA	145.01	#RDGC	KC6LHA	LINKED VIA KB6GVT
WA6YHJ-1	Livermore,CA	145.09		WA6KTK	223.56E
N6YIH	March AFB,CA	145.e5		KC6LHA	223.56
KI6YK	San Ramon,CA	144.93		KA6FUB	223.54B
WB6YMH-2	Palos Verdes,CA	145.36 -	NRC220	K6VE	223.56, 439.025, Phone Port 310/541-2503
N6YN	Westchester,CA	145.05		K6VE	14.111B, 441.5B PHONE PORT 310/670-2341

** -Z-

KB6ZBI	Palmdale,CA	145.01		KC6LHA	223.56 LINKED VIA WA6YBN
N6ZGY	Clovis,CA	145.73		WA6KTK	223.56B LINKED TO K6RAU
KG5ZI	Las Vegas,CA	145.05		>07LJ	145.61 439.05
WB6ZVW	Morgan Hill,CA	7.10 2		AA4RE	*NF* 7.108(Nights), 223.58

NOTES:

1. Designation as a WESTNET FULL SERVICE BBS signifies that the BBS handles all message types and will ensure forwarding within the system before billing items on his own Board (Normal screening for illegal items excepted.) *NF* in the NOTES field signifies a special class of WESTNET BBS that does not offer full services but is a Board offering special forwarding or other services to the network.

2. All WESTNET BBS's should insure that all of the local stations on this list are authorized as BBS's and included in their forwarding file. In addition, include the following Standard Regional and Area H-designators, and special Station Designators, for other areas within your state (or in an adjoining state).

- REGIONAL AND AREA HIERARCHIAL DESIGNATORS (R&A H-Designators)
The use of Standard R&A H-Designators assists in the routing of WESTNET traffic and helps minimize forwarding file maintenance. Recognized R&A H-Designators are of the form #xxxst; where "xxx" is the one to three character regional or area code and "st" is the State Designator. Standard Regional and Area H-Designators currently supported in WESTNET are:

Arizona:	None required	
California:	#CENCA	Central California
	#LACCA	Los Angeles County California RACES Sub-net.
	#SOCA	Southern California
	SYSOPs in Northern CA have elected to use the non-standard #NOCAL in their area.	
Colorado:	#NECO	Northeastern Colorado
	#NWCO	Northwestern Colorado
	#SECO	Southeastern Colorado
	#SWCO	Southwestern Colorado
Idaho:	None required	
Montana:	#SEMT	Southeastern Montana
Nevada:	SYSOPs in NV have elected to use the non-standard #NENEV, #NONEV, and #SONEV for their state.	
New Mexico:	None required	
Oregon:	None required	

Utah:	#SEUT	Southeastern Utah
	#SOUT	Southern Utah
Washington:	#NWWA	Northwestern Washington
Wyoming:	#CENWY	Central Wyoming
	#NEWY	Northeastern Wyoming
	#SEWY	Southeastern Wyoming

- SPECIAL STATION ROUTING DESIGNATORS

WESTNET stations are requested to support the following Special Station Designators which may be used in the TO field of a message.

DCSLA	pointing toward KB6NJF.#SOCA.CA	L. A. County Disaster Comm Svc.
OESSAC	pointing toward WA6NWE.#NOCAL.CA	Headquarters - CA States OES
REDCRS	pointing toward N6IIU.#NOCAL.CA	American Red Cross State Hdqtrs.

4. WESTNET BBS's are requested to provide for proper forwarding of ZIP addressed NTS messages. For California BBS's this routing is defined in DESIG.NTS (Northern California) and CASZIPS2.NTS (Southern California).

5. The character "B" following a frequency indicates that ONLY BBS access is allowed on that port.

6. The HOME FREQUENCY is the BBS's primary local area User access frequency. The ACCESS NODE is the Node which other MailBoxes can use for access. BBS's served by LAN Gateway or Forwarding Stations are indicated by entries in the HUB BBS column and/or a "LINKED VIA" entry in the Notes field.

7. MAN and LAN concepts are being effectively incorporated into the Amateur Packet Networks in several areas. The following Networks are reflected in this issue:

NET NAME	NETWORK/AREA	HUB BBS	FREQUENCY
AZNET	Arizona Metropolitan Network	N7MRP	145.11-, 145.15-
COAST	Greater So. California MAN	KB6JES	223.58/439.00
EBAY	East San Francisco Bay LAN	KA6FUB	433.41
GILNET	Gilroy/Hollister LAN	AA4RE	223.58
IEMAN	Riverside/San Bernardino MAN	KB6GVT	223.56
LAMAN	Los Angeles Area MAN	K6VE	223.54
NMNET	New Mexico Metro Net	WB2ARS	*
MRYBAY	Monterey Bay LAN	N6IYA	223.70
NBAY	No. San Francisco Bay LAN	WD6CMU	223.72
SACVAL	Sacramento Valley LAN	WA6RDH	223.54
SBAY	So. San Francisco Bay LAN	N6OMY	223.62
SBNET	Santa Barbara Section MAN	K6IYK	223.56
SDMAN	San Diego Metro Net	KC6NZN	223.54

8. SIGNIFICANT CHANGES THIS ISSUE:

a) Individual Stations

CALLSIGN	ACTION/CHANGE	SOURCE
WA6AEO	IDENTIFIED AS A PBBS - REMOVED FROM LIST	K6RAU
W6AKF (-0, -1, -3, -9, -12, -13)	AKF System reorganized to run on multiple processors using a variety of software. System now a Full-Service Board.	W6AKF
[illegible]7AE	New BBS in Klamath Falls, OR	K6RAU
KC7CG	User Frequency now on 145.01 and running TBB.	N7MRP
WI7D	New BBS in Las Vegas, NV AMTOR	KE7LJ
KS6EE	Now linked to KI6EH with BBS port on 223.70	K6RAU
WA6EWV-1	New BBS in So. Lake Tahoe, CA on 144.97, 223.60B	K6RAU

forwarding responsibility.

Thank you to all who assisted by sharing current information from their area.
Changes or corrections should be sent to K6IYK @ K6IYK.#SOCA.CA.USA

[End WESTNET.555 - 01/30/93]

N7EQN QTH N7EQN Redwood City, CA (SKYWARN)
73 DE WP @ WD6CMU

The database is in a growing state so it may not contain the callsign you're interested in. If you wish to add an entry, please make sure that the information is accurate.

RADIO MODIFICATIONS SERVER

RADIO MODS DATABASE UPDATE

The radio mods database server has become tremendously popular with hams all over the country. The hf forwarding network, in particular, has been adversely impacted by the traffic load. Some changes have to be made to reduce this load. Here are the changes:

1. I am coordinating with bbs's in FL, CO, NE, GA, OK, NM and MO. These bbs's will soon be running shadows of the database. Once these stations are set up to run the server, users will address their REQFIL requests to the nearest participating bbs. This will keep much of the REQFIL traffic off of hf where it is currently jamming up the forwarding network. Please continue to send your REQFIL requests to KJ6FY until further notice.

2. Until further notice, please limit your REQFIL requests to 3 files per day. Some users are requesting 5 or more files at a time and this really jams up the network.

Many of you have written to tell me that you have not received responses to your REQFIL inquiries. This may be due to the fact that some hf sysops are refusing to handle REQFIL traffic. If your response was accidentally routed via one of these stations it may have been killed.

My thanks to those sysops that have volunteered to run shadow servers. A special thank you to the hf sysops that have continued to forward REQFIL traffic.

73,
Ross KJ6FY

REQQTH SERVER

From : N6YN
To : ALL

Hi, if you are interested in finding the QTH of a callsign or searching for the callsign and QTH when all you have is a first and last name, then read on. The N6YN BBS is currently running a US and Canadian callbook server dated June '92.

To find one QTH type:

```
SP REQQTH @ N6YN
QTH WB6YMH          (put in the Subj field: to find info on wb6ymh)
/ex or Ctrl Z       (to end the message as normal)
```

To find multiple QTHs type:

```
SP REQQTH @ N6YN
                    (leave the Subj field BLANK)
WB6YMH              (put in the Msgs field: to find info on calls)
```

N6YN
K6VE
[illegible]
K6UNO
/ex or Ctrl Z (to end the message as normal)

search for the callsign and QTH when you have a first and last name type:

SP REQQTH @ N6YN
FIND ED ADAMS (put in the Subj field: to search for ed adams)
/ex or Ctrl Z (to end the message as normal)

To get more info on the callbook server type the following:

SP REQQTH @ N6YN
I (put in the Subj field: I for info)
/ex or Ctrl Z (to end the message as normal)

All the best! - 73 Ed N6YN

REQSAT SERVER

From: AA6QN@AA6QN.#SOCA.CA.USA.NA
To : REQSAT@ALLCAS
This Doc explanes the way's and why's of using the REQSAT server. Please take time to read it, as it will make my life easier. C Ya

REQSAT.DOC

AA6QN has been set up specifically to provide a fast means of sending personal mail on long haul routes via the packet satellites. BBS sysops are being contacted to ask them to forward mail to me for the countries that are served by the SATGATE mail system. If your local BBS sends mail to me automatically, then you do not need to do anything special in addressing your messages. (If you are in any doubt about message routing from your local BBS then please contact your local BBS sysop or myself.

The countries available so far are;

JPN = (KOR, PHL, CHN, TWN, THA, PKR, AS)
JUS = (ALL TERITORIES)
VZL = (NEW ZEALAND AND ISLANDS)
GBR = (UKGN, GREAT BRITIAN ETC)
ELG = (FRA, BEL, DEU, CHE, NLD, LUX, AUT, FRG, EU)
ERC = (SUN, KUW, LBN, HUN)
4SR = ISR
ERE = (IRE, DNK, GBR)
4SP = (ESP, ITY, POR, ITA)
4AH = (TAIHITI, PYF AND SORROUNDING ISLANDS)
ERG = (PER, SA)
4 = (S. AFRICA)
EJB = (GUAN, JAM, PR, CAR, GTM, CRI)
4SA = (ALL STATES, AK, HI)
EIN = (FIN, SWE, NOR)

if your local BBS is not yet set up to forward mail to me then you will need to format the message you wish to send in a particular way. As an example, you want to send a message to Jim N6ABC whose mailbox is K6XYZ. At your BBS prompt send your message to:

SP REQSAT @ AA6QN [REQuest SATellite at AA6QN]
Big problems. [Enter the subject as normal]

N6YN
K6JE
AA4RE
K6UNO
/ex or Ctrl Z (to end the message as normal)

To search for the callsign and QTH when you have a first and last name type:

SP REQQTH @ N6YN
FIND ED ADAMS (put in the Subj field: to search for ed adams)
/ex or Ctrl Z (to end the message as normal)

To get more info on the callbook server type the following:

SP REQQTH @ N6YN
I (put in the Subj field: I for info)
/ex or Ctrl Z (to end the message as normal)

All the best! - 73 Ed N6YN

REQSAT SERVER

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AUS = (ALL TERITORIES)
NZL = (NEW ZEALAND AND ISLANDS)
GBR = (UKGN, GREAT BRITIAN ETC)
BLG = (FRA, BEL, DEU, CHE, NLD, LUX, AUT, FRG, EU)
GRC = (SUN, KUW, LBN, HUN)
ISR = ISR
IRE = (IRE, DNK, GBR)
ESP = (ESP, ITY, POR, ITA)
TAH = (TAIHITI, PYF AND SORROUNDING ISLANDS)
ARG = (PER, SA)
SA = (S. AFRICA)
CUB = (GUAN, JAM, PR, CAR, GTM, CRI)
USA = (ALL STATES, AK, HI)
FIN = (FIN, SWE, NOR)

So if your local BBS is not yet set up to forward mail to me then you will need to format the message you wish to send in a particular way. As an example, you want to send a message to Jim N6ABC whose mailbox is K6XYZ. At your BBS prompt send your message to;

SP REQSAT @ AA6QN [REQuest SATellite at AA6QN]
Rig problems. [Enter the subject as normal]

```
SP N6ABC @ K6XYZ.NOCAL.USA.NA      [Enter the REAL address as the FIRST
Hi Jim the rig has been....        [line of the message. A SPACE MUST exist
text text etc.....                 [between SP and the first callsign.
/ex
```

f you add the full Hierarchical address, as shown above, it will aid in
e correct routing of your message.

So to sum up, check that I CAN forward mail to your destination country by requesting a REQFIL of this message (\FBB\USERS\DOCS\REQSAT.DOC) and check the countries currently available, then at your BBS prompt enter;

```
SP REQSAT @ AA6QN
```

When asked for the subject enter whatever you like;

```
TNC problems again!!!
```

When asked for the Message the VERY FIRST LINE must contain the real address INCLUDING THE HIERARCHICAL ADDRESS;

```
SP N6ABC @ K6XYZ.NOCAL.USA.NA
```

Then enter the rest of the message as you would normally ending with the usual;

```
/EX
```

When the message arrives here it will be automatically re-addressed according to the first line of the message, the subject you entered will be the same and ALL the headers will remain, so anyone doing a SR reply will have the reply sent back to the BBS you entered the message on.

KB6CYS WEATHER SERVER

```
GBEAR:AA6TN-1> Connected to KB6CYS
WED JAN  6 12:15:16 PM  TMP 55 DP 54 R/H 94%  PRESS: 29.82 FALLING  -.02/HR
WIND: NORTH EAST          AT 02 MPH     WIND CHILL: 55 DEGREES

PEAK GUST= 7 MPH AT 11:42:35 AM
TMP MAX= 56 AT 11:37:41 AM                TMP MIN= 54 AT 10:47:39 AM

PRCP= 0  MONTH= 0  SEASON= 0
```

t of available commands :
Abort - Abort listing.
Bye - Log off the BBS.
Conference - Access to conference.
DOS - Access to FBBDOS, or to download a file.
FBB - Access to server mode.
Gateway - Access to other frequences by 'gateway'.
Help - Help.
Info - Information about the system.
Jheard - List of the last few connected stations.
Kill - Kill messages.
List - List messages.
Make - Copy a message to a file.
Name - Change your name.
Zip - State your zip-code.
homeBBS - Type your home-BBS.
Option - Select options (paging, language, list/read personal etc.
Servers - Show which servers are available in this BBS.
Program - Run (show) certain DOS-programs.
Read - Read messages.
Send - Send messages.
Talk - Talk to SysOp.
Upload - Upload a file to the BBS.
Verbose - Verbose read of messages (like R, but with forwarding
headers).
What - Which files are available.
Expert - Change between Normal and Expert.
Yapp - Transfer binary files with the Yapp transfer protocol.
Delete - Delete a file.
Append - Only for sysops: Append a file after a message.
Send text - To send a text to another station connected to the BBS.
Connect - To connect another station connected to the BBS.
Info - Short version of the I-command.
Forwardet - Only for sysop: Show what BBSs that will receive, or
already have received a message.
Wildcard - Many possibilities, like @,?,#,=,*

the middle of a long listing from the BBS, you can send the command
(ABORT) to stop the listing. The listing will stop after a short while.
d the BBS will ask you if you want to read some of these messages
isting continues after reading the messages), if you want to continue
sting messages, or if you want to stop all listing. If so, the normal
S-prompt will return.
can also be used many other places, for example when downloading long
ll-files.

e "B" command logs you off the PBBS and disconnects you.
Type "B" to LOG OFF gracefully [Bye].
sure to hit <Enter> or <Return> after each command.
TE: You may also LOG OFF by disconnecting.

The "CW" command lists the call-signs in conference.
The "C" command lets you enter in conference.

conference, all commands must begin by a point on first column.
e commands are :

[port] CALL-SIGN [V REPEAT ...] connects a call-sign on a port.

disconnects a user from the conference.
gives you this help file.
lists the call-signs in conference.
lets you leave the conference.

ommand has 2 different functions.

If you send D [filename], the mailbox will send you the file with that name. This file must be in the root-directory for users. If the file is in a subdirectory, you must use fulle path, like this:
D VHF/VHF.DX
See also help with the W-command (? W).

If you send the letter D alone, you will enter FBBDOS. The commands in FBBDOS are very similar to those of MS-DOS. Users have access to a part of the BBS's hard-disk in FBBDOS. Following commands are allowed here:

? HELP	>=	Use one of these to get help.
DIR	>=	List files in this directory.
MD MKDIR [name]	>=	Use one of these to make a new directory.
RD RMDIR [name]	>=	Use one of these to remove a directory. You cannot be in the directory you want to remove, and the directory must be empty.
CD [name]	>=	Use CD to change directory.
COPY [from] [to]	>=	Copy a file named [from] to a file named [to]. Can also be used to copy between directories.
DEL [filename]	>=	Deletes the file [filename].
TYPE [filename]	>=	Download the ASCII-file [filename] from the BBS. The file is divided into pages, if you use paging when in BBS-mode. The file must be in your current directory.
GET [filename]	>=	Identical to TYPE, but always without paging, and the file is always ended with a CTRL-Z.
PUT [filename]	>=	Use this command to upload an ASCII-fil to this directory.
YPUT and YGET	>=	These are identical to PUT and GET, but uses the YAPP-protocole for binary transfer.
XPUT and XGET	>=	These are identical to YPUT and YGET, but uses the XMODEM-protocole for binary transfer. Only for telephone-modem.
EDIT [filename]	>=	This is a small editor for editing texts and files in the BBS. You can use this editor ONLY on files that YOU have uploaded to the BBS. Get more info with ? EDIT
F B EXIT QUIT	>=	Use one of these to go back from FBBDOS to BBS-mode.
O	>=	Use this to set "options" like in BBS-mode.
LIST	>=	Same as DIR, but shows also descriptions of files, if users have provided such an description..
PRIV	>=	Gives special users access to a special directory.
VIEW	>=	See the contents of an archived file like *.ZIF. *.LZH etc. VIEW filename.ext
NEW	>=	List all new files since you last sent NEW

command gives you access to SERVER-mode and special commands.
In "server-mode" you can do several things:
Get statistics of the use of this mailbox.
Read documentation of different kind.
Read info on all users of this mailbox.
Calculate QTH-locatorer and distances between several QTH-loactors.

Calculate trajectory of different sattellites.

more information, type ? when you have entered SERVER-mode. For
iled information, type ? [command].

command gives you access to the GATEWAY (if the BBS allows gateway, and
if there is a channel available on the gateway-port).

          - Gives you information about this BBS.
callsign] - Gives WP informations about [callsign]
bbs]   - Gives the known users of [bbs]
          - Gives some statistics on WP.
zip]   - Searches for [zip] in WP.

Willcards are allowed.

mmand sends you a list of the last connected stations.
pe JK to see the last connected stations.
pe JA to see callsigns that have connected to TNC-A.
pe J1 to see callsigns that have been MONITORED on TNC-A.
pe JB to see callsigns that have connected to TNC-B.
pe J2 to see callsigns that have been MONITORED on TNC-B.
d so on...

mmand is for killing messages TO or FROM you.
pe K[space][message#] to delete one special message.
pe KM to delete all messages to you, that you have read [Kill Mine].
is command will NOT kill messages that you have not read !

You cannot delete messages that are not TO you or FROM you, only
SYSOP can dio that..

P: In front of K-commands, you can put an extra K, like KKM, KKF etc.
In that manner the messages will get A-status (normally K) at once.

mmand LISTS all messages in the mailbox.
lists all new messages since you last issued a L-command.
lists only bulletins.
for very special listings. See further down..
lists all messages TO YOU [List Mine].
lists all UNREAD messages to you [List New].
10 lists the last 10 messages in the mailboxen [List Last].
[Text] lists messages with [text] in the subject.
[callsign] lists messages FROM [callsign].
[callsign] lists messages TO [callsign].
lists local bulletins with no @BBS-field.
[callsign] lists messages @[callsign].
[message#]- lists ONLY messages with higher number than [messages#].
[message#]-[message#] lists all messages between these numbers.
lists all UNREAD messages (status N) to and from you.
lists messages in revers order, starting with the oldest one.
LR can replace L in most contexts (ex: LR 1-100)

amples:
To list messages over #325, type L 325-
To list messages from #300 to #350, type L 300-350

Check number of active messages before doing a list-command, to avoid listing every messages in the system. This is easy to check with the V-command.

ecial command LC:
th this command you can have very special listings. If you once type DX, then all list-command (except LM and LN) will only list messages th a TO-field of DX. If you type LC *DX*, listings will contain all -fields that have DX in it, for example VHFDX, DXHF etc. To go back "normal", send LC *
* or LC ; gives a list of available LC-fileds.

[number] [name] : Copy a message to file.
[number] [name] : Same, but in same format as R (msg#).
[number] [name] : Same, but in same format as V (msg#).
ese commands will overwrite old messages.

[number] [name] : Copy a message to file.
A [number] [name]: Same, but in same format as R (msg#).
A [number] [name]: Same, but in same format as V (msg#).
ese commands do NOT overwrite old messages, but append the next text to e old file.

ly for sysops; M can be used instead of L. The listing then will have the BID included in the subject.

command is used to enter (or later change) your name in the BBS. You use max 12 characters. "Phoney" names will be deleted, use your own rst-name.

Type N[space][first-name]

command gives you different options:
alone shows you what language you are using, paging and base-number.
Type OP to toggle paging on messages.
Type OP [number-of-lines] to select paging with a specific number of lines per page.
Type OL alone to get a list of available languages.
Type OL[space][language-number] to choose a language.
Type ON alone to see your base-number.
Type ON [number] to choose a new base-number. The number you type, will be multiplied by 1000, so if you type ON 54, your base-number will be 54000. After that, you can type R 25 to read message number 54025.
It is also allowed to type ON 54000.
Type OR to choose if you want to be able to list and read all personal messages in the BBS (if your BBS allows this...).
Type OM to choose if you want to receive the list of new messages at every connect.

Only for sysops: Use PR to toggle printer on/off.

R-command is for reading messages (not files).
- Type R[space][message#] to read one message.
  You can chain several message#, seperated by a space.
- Type RM to read ALL messages adressed to you [Read Mine].
- Type RN to read all NEW messages to you [Read New].
- Type RU to read all UNREAD messages (status N) to or from you.
- Type R< to read messages from a certain callsign.
- Type R> to read messages to a certain callsign.

S-command lets you send messages.
- Type S[type][space][callsign] to send a message.
  Type can be P for Personal or B for Bulletin.
- Type S[type][space][callsign] @ [callsign] to send a message to a station at another BBS.
- Type SB ALL to send a bulletin to ALL.
- Type SR[space][messages#] to reply to a special message. (Send Reply).
- Type SC[space][messages#][space][callsign] to send a copy of a message to another callsign. (Send Copy). You can write a message before sending the CTRL-Z, then the copy will be appended to your text. If you don't want to do this, just send CTRL-Z instead of any text.

T-command calls the BBS System Operator (SysOp).
If SysOp IS available to chat, you'll get a response within ONE MINUTE. Otherwise, the BBS will advise you that SysOp did not answer. You will be returned to the command prompt and can continue normally.

U-command can be used to upload an ASCII-file to the "root"-directory of the FBBDOS. - Type U [filename] to send the ASCII-file.
You can also use U-command to upload a file to a sub-directory of FBBDOS, like this:
U VHF/TEST.RES

The V-command shows you the specific version of this PBBS, the date of the software release and the copyright notice. This also shows the number of active messages and the next message number.
- Type V to see this PBBS's software version.

The V-command also lets you READ MESSAGES with a verbose listing, including the message routing. Use like R-commands.

- Type V[space][message#] to READ a specific message.
  You may have several message numbers per line.
- Type VM to READ ALL messages addressed to YOU [Read Mine].
- Type VN to READ ALL NEW messages addressed to YOU [Read New].
  To READ msgs #313 and #325 type "V 313 325". Don't forget SPACE.

Use the W-command (alone) to get a list of files in the users root-directory.
Use the W-command with path to see what is in the sub-directories, like this:

W LOCAL (see what is in the LOCAL sub-directory)

The X-command toggles your status between "normal" and "eXpert" user.
"Normal" mode gives you complete prompts and standard messages.
"eXpert" mode gives you a very short command line and nothing else.
- Type X to toggle your status between "normal" and "eXpert".

The Y-command calls YAPP protocol for binary file transfer.

Your software must use YAPP protocol to transfer binary files.

- Type YW to list directory of binary files.
- Type YI to list directory with labels.
- Type YN to list directory of new binary files since your last logon.
- Type YU [filename] to send a file TO the BBS. You can't replace an existing file.
- Type YD [filename] to receive a file FROM the BBS.
- Type YZ [filename] to delete a file from the BBS.

Use Z-command to for delete files in the BBS from BBS-mode.
Type Z [filname] to delete the file.

REQDIR lets you "order" a list of available files from another BBS.
Then, later, you can "order" one of those files with REQFIL. Type
REQFIL for more info on the REQFIL-server.

If you want to see which files are in the root-directory of LA1B BBS, and
your own BBS if F6FBB, you send a message like this:
SP REQDIR @ LA1B
As subject you write
. @ F6FBB (if F6FBB is your home-BBS)
The message can be empty, a CTRL-Z or /EX is enough.

After some time, when the message has had time to be forwarded to
LA1B BBS, you will receive a message here in F6FBB BBS containing a list
of files available in the root-directory of LA1B BBS.

If you want to look in one sub-directory (<DIR>), you can do this in a
similar way. Example: If you want to look in the LOKALT-directory at
LA1B, you send a message like this:
SP REQDIR @ LA1B
As subject you type
LOKALT/*.* @ F6FBB (if F6FBB is your home-BBS).

Beware: Not all BBS-types support REQDIR. FBB and MBL-type BBSs do...

REQFIL lets you "order" a file from another BBS. Only ASCII-files,
binary-files cannot be sent to you with REQFIL.
A list of available files can be obtained using the REQDIR-server.

If you want to order a file from the root-directory of LA1B BBS,
and your home-BBS is F6FBB, you send a message like this:

SP REQFIL @ LA1B
As subject you type the name of the requested file, followed by a @-sign and your home-BBS. Like this:
NORSK.MAN @ F6FBB (if F6FBB is your home-BBS).
The message can be empty, a CTRL-Z or /EX is enough.

After some time, when the message have had time to be forwarded to LA1B BBS, you will receive a message here in F6FBB BBS containing the requested file.

If you want to order a file from a sub-directory, (<DIR>), you do this is in a similar way. Example: If you want to order the file TEST.TST in sub-dir called LOKALT, you type:
SP REQFIL @ LA1B
As subject you type:
LOKALT/TEST.TST @ F6FBB (if F6FBB is your home-BBS)

Beware: Not all BBS-types support REQFIL. FBB and MBL-type BBSs do...

These commands are available for sysop (local and remote):

DOS	:	SYSOP can now run DOS-programs from remote. Read the help for this under FBBDOS with command ? DOS.
DU [callsign]	:	Show info on that callsign.
DS	:	List all callsigns defined as BBS.
DE	:	List all excluded callsigns.
DS	:	List all sysops.
DX	:	List all "expert"-users.
OP	:	List all users that have paging on.
EM [msg#]	:	Edit a message#.
EU [callsign]	:	Edit one user. A '.' deletes a field.
FA [msg#] [BBS]	:	Mark message# for forward to BBS.
FB (BBS)	:	List messages that will be forwarded to BBS. The messages are listed as with a standard L-command with BIDs (M-command).
FC (BBS)	:	Shows the route a message from me to BBS will take. If I send FC LA2D, and the BBS respond with LA8D, it means that messages from me to @LA2D, will be sent via LA8D.
FD [msg#] [BBS]	:	Remove message# from forward to BBS.
FL [BBS]	:	List messages that will be forwarded to BBS.
FT [BBS]	:	List size of messages ready for forward to BBS. Shows number of personal messages and bulletins, and also the total size in kilobytes.
FT	:	FT alone shows the same as above, but for ALL BBSs that there pending forwards to.
FU [number]	:	To disconnect a user from a channel. Channel-number must be used, not callsign.
FV	:	Start forward-scan.
FN [messsage#]	:	List BBSs waiting for a message.
FW [argument]	:	Start forward to BBS (callsign) or port. FW 9 starts forward out on all ports. FW LA1B starts forward to LA1B.
FS [argument]	:	Stop forward. Argument; look under FW.
FR [argument]	:	Start revers forward. Argument; look under FW.
FH (argument)	:	Hold messages, give them H-status.
K [message#]	:	Same as FN.
K [messago#]	:	From version 5.10i sysop can also kill UNREAD messages.
KF	:	Kill all messages that have been forwarded.
K [message#]	:	Kill message. Goes directly to status A, and is

deleted with next EPURMESS.

[illegible] [callsign]
[illegible] [callsign] : SYSOP can kill messages to or from a callsign.
[illegible] [BBS] : Kill all messages to this @BBS-route.
LABEL (filename) : To change the description of a file in FBBDOS.
[illegible](callsign) : To change a user's data in USER-DATA.

NB: All K-commands can be preceded by an extra K. Messages will then go directly to A-status (not K). Example: KKM

LU : List all UNREAD messages (status N) in the BBS.
M (replace L) : Can be used by sysop to replace L, like: ML for LL, M 100- for L 100- etc. All listings will then have the BID in the subject-field.
M [msg#] [file] : Copy a message to a file. Overwrites existing file.
MH [msg#] [file] : Like M, but with same format as H [msg#]. Overwrites.
MV [msg#] [file] : Like M, but with same format as V [msg#]. Overwrites.
MA [msg#] [file] : Copy a message to a file. Appends to existing file.
MHA [msg#] [file] : Like M, but with same format as H [msg#]. Appends.
MVA [msg#] [file] : Like M, but with same format as V [msg#]. Appends.
PR : Toggle printer on/off. CAREFUL when doing this remote
RE : REview messages with status Hold.
RU : Read all UNREAD messages in the BBS.
SYS : Send this command to become remote-sysop.
S [filename] : Send an ASCII file in GATEWAY-mode. Must go to command-mode first (by pressing ESC).
W (filename) : To be used under GATEWAY to capture text in a file. You must first change to Cmd:mode. End capture with W.
YL [filename] : Change the label of a YAPP-file.
YZ [filename] : Delete a YAPP-file.
[illegible] [filename] : Send a binary file in GATEWAY-mode. Must go to command-mode first (by pressing ESC).
YD [filename] : Receive a binary file in GATEWAY-mode. Must go to command- mode first (by pressing ESC).

: Show status for all channels right now.
: Reboot PC.
: Stops the BBS-program

Here is an overview of all function-keys:

F1 - General help on all function-keys.
F2 - Connect to the BBS locally with the console-callsign.
F3 - Disconnect a channel.
F4 - Start or stop forwarding.
F5 - Toggle monitoring on/off. With monitor on, the lower part of the screen displays the monitored traffic, while the upper part of the screen shows traffic in the BBS. Number of lines in upper/lower part of the screen, can be adjusted with the arrow-up or arrow-down keys.
F6 - Change console-callsign. That callsign is used when connecting to the BBS with F2. The callsign have sysop-status.
F7 - Program TNC directly.
F8 - Reboot PC. Can be done at once, or when all channels are free.
F9 - Gateway, using console-callsign.
F10 - Talk to a user (that have sent a T) or initiate a chat with a user.

SHIFT-F1 - Shows pending forward(s). Shows number of personal messages, bulletins, and the total amount of kB waiting to be forwarded.

ALT-F2 - Shows all callsigns connected to the BBS.
ALT-F3 - Start or stop forward-scan.
ALT-F4 - Shows the last connected callsigns.
ALT-F5 - Starts a very simpel text-editor (use F1 for help there).
ALT-F6 - Various "options" : Sysop is inn ?
Beep at connect ?
Show callsigns etc. on every channel ?
Gateway allowed ?
Justificetion ?
ALT-F7 - Import messages from file.
ALT-F8 - Export messages to file. Messages that are waiting to be forwarded to one BBS. These messages can be forwarded to a file.
ALT-F9 - Exit to DOS. The BBS is halted during that time.
ALT-F10- Stop the mailbox-program. Can be done at once, or when all channels are clear.

CTRL-F1 to CTRL-F10 holds pre-defined texts, that are sent when pressing that key. The texts are in the file MEMO.SYS.

';WW6L (A,B,C,D,F,G,I,J,K,L,M,N,O,F,R,S,T,U,V,W,X,Y,Z,?) >

The BPQ Node in an Expanding Network

by Karl Medcalf WK5M, and Phil Anderson WØXI,
in cooperation with John Wiseman G8BPQ

July 20, 1990, Lawrence, Kansas

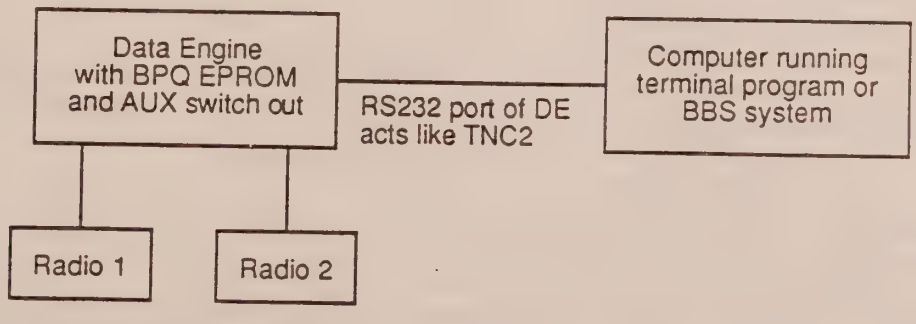
The release of the Kantronics Data Engine, along with the development of their 9600 baud (G3RUH compatible) modem has now added a new dimension to the meaning of a Network Node. With the open architecture of this packet controller, and the flexibility now possible, network expansion and high speed operation is now possible with future expansion in mind.

John Wiseman (G8BPQ) has completed development of his packet switch software in an EPROM version, suitable for installation in the Data Engine. The flexibility written into this EPROM allows you to configure your node to meet your specific requirements. First, let's look at some of the specific features of the BPQ node. This is not a new node, as the G8BPQ packet switch software has been running on numerous systems in its PC based version. Using it in this fashion allows any KISS mode TNC to be a Network Node, providing all the features of Net/Rom nodes, and a few new features.

One of the major advantages of the BPQ node over the other nodes is the "stay" option when connecting to another node or an end user. When this option is specified in the Connect command, the node will not cause a complete disassembly of the network link when the far end of the connection initiates a disconnect. As an example, if you connect to a node named "KSLAW", and then issue a connect of the form "C KSWCH S", this will activate the stay function and connect you to the KSWCH node. From this point you could connect to an end user, or a PBBS near the KSWCH node. Since the stay option is in effect, when you are finished with the PBBS you simply use its BYE command, causing the PBBS to disconnect. When that disconnect is received by the KSLAW node, you will not be disconnected, but you will be sent a message "Returned to node KSLAW". You may now issue further commands to the node.

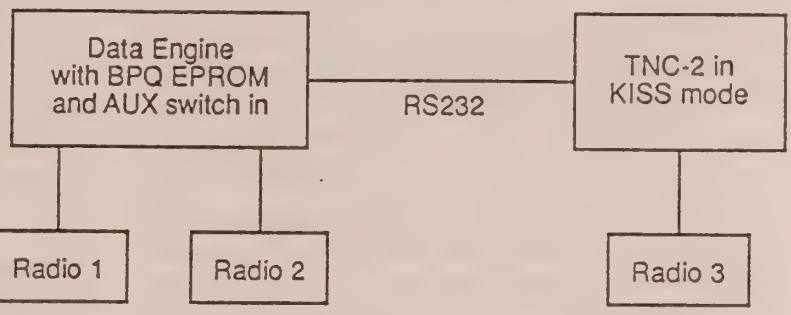
Since the BPQ node software has previously run only in a PC computer (normally co-located with a BBS system) this meant that the node required a computer to be connected and running at all times. Now that the code has been made available in an EPROM version for the Data Engine, the computer is no longer required. Another advantage of this implementation is that since the Data Engine is a dual-port unit, you can now operate a simple two-port Network Node using a single Data Engine with the BPQ EPROM code installed. The serial port of the Data Engine can be configured to appear like a TNC-2, allowing regular use with a simple terminal program, or access by a BBS system, just as though the BBS were connected to a TNC-2. (See figure 1)

Figure 1



Frequently, we have the need for more than two radios in a single node, and this has been cumbersome in past implementations of node firmware. With the BPQ code running in the Data Engine, a simple press of the front panel AUX switch changes the serial port from a TNC-2 port to a KISS link, which may be connected to any KISS mode TNC. In this configuration (see figure 2), you can have a three-port Network node with a single Data Engine using the BPQ code and a TNC-2 in KISS mode. No specific requirements exist for the TNC-2, except that it runs the KISS firmware. Since the Data Engine supports both 1200 and 9600 baud modems, as well as virtually any other known modem, you could configure this three-port node as a gateway for 1200 baud users onto a 9600 baud backbone, or even to a PSK modem for a satellite gateway.

Figure 2

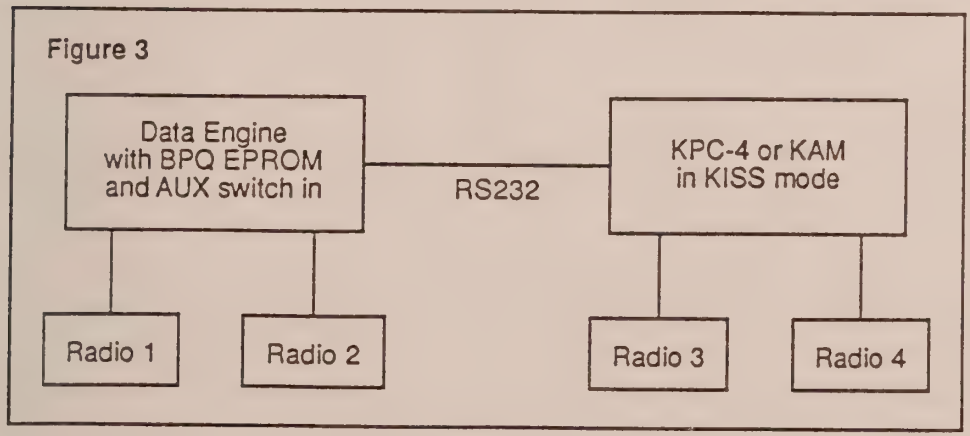


Need more than three ports? Not a big problem with the BPQ/Data Engine combination. A simple 4-port node can be configured using the Data Engine/BPQ combination with a KPC-4 or KAM (KISS mode) connected to the Data Engine serial port. Since the BPQ code allows for dual-port KISS, this provides a low-cost, no-diode implementation of a 4 port configuration. The four ports could all be different radios, bands, speeds and so forth. (See figure 3).

There is another implementation possible due to the incorporation of a new method called "multi-drop" kiss. John Wiseman implemented dual port support using the Kantronics scheme. Since the KISS implementation as originally specified only uses the low nibble (4 bits) of the control byte to specify the function, the high nibble was used by Kantronics in version 2.84 and later of their firmware to address the two ports of the KAM and the KPC-4. If the high nibble was zero, then the unit would address one port, and if the high nibble of this byte was non-zero, it would address the other port.

John has extended this implementation to allow all four bits of the upper nibble to be significant, thus permitting up to 16 different KISS addresses to be defined. He has supplied in his distribution, versions of the KISS code for the various TAPR type TNCs, and documents which byte of this code to change in order to tell each TNC which address it is assigned. Kantronics is also making an EPROM image available for free, non-commercial use, which contains this capability, along with instructions for changing the correct address information. This is available for all Kantronics TNCs direct from the manufacturer's phone-line BBS (913-842-4678).

Figure 3



When using this method, all of the TNCs can be attached to a single serial port, such as the serial port of the Data Engine. A single diode is connected in the RXD line of each TNC, with the anode connected to the TNC and the cathode connected to the serial port of the com-

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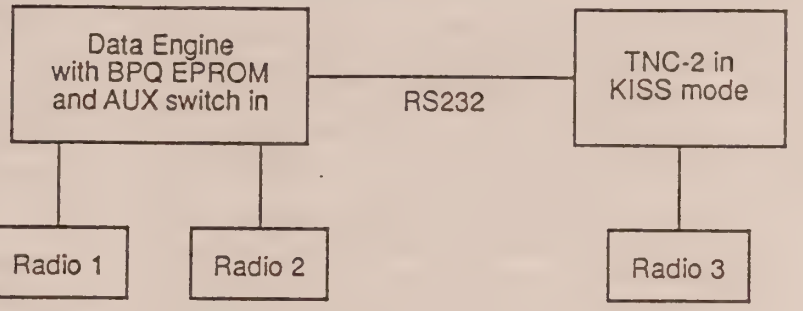

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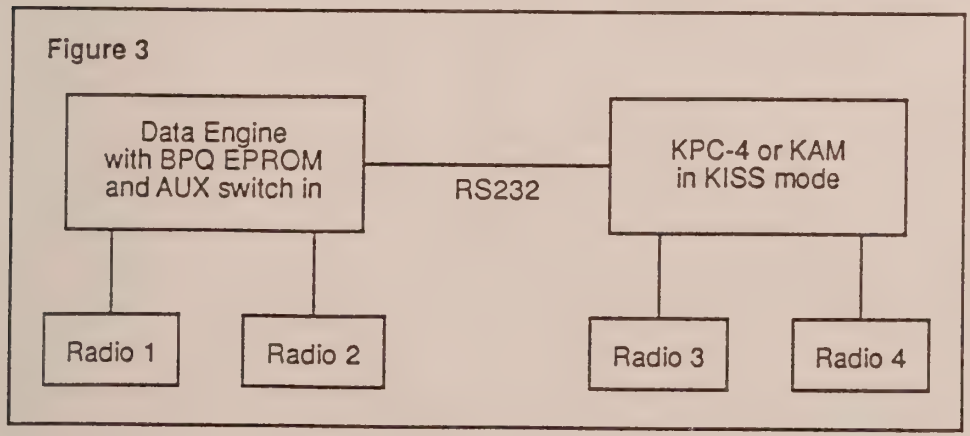


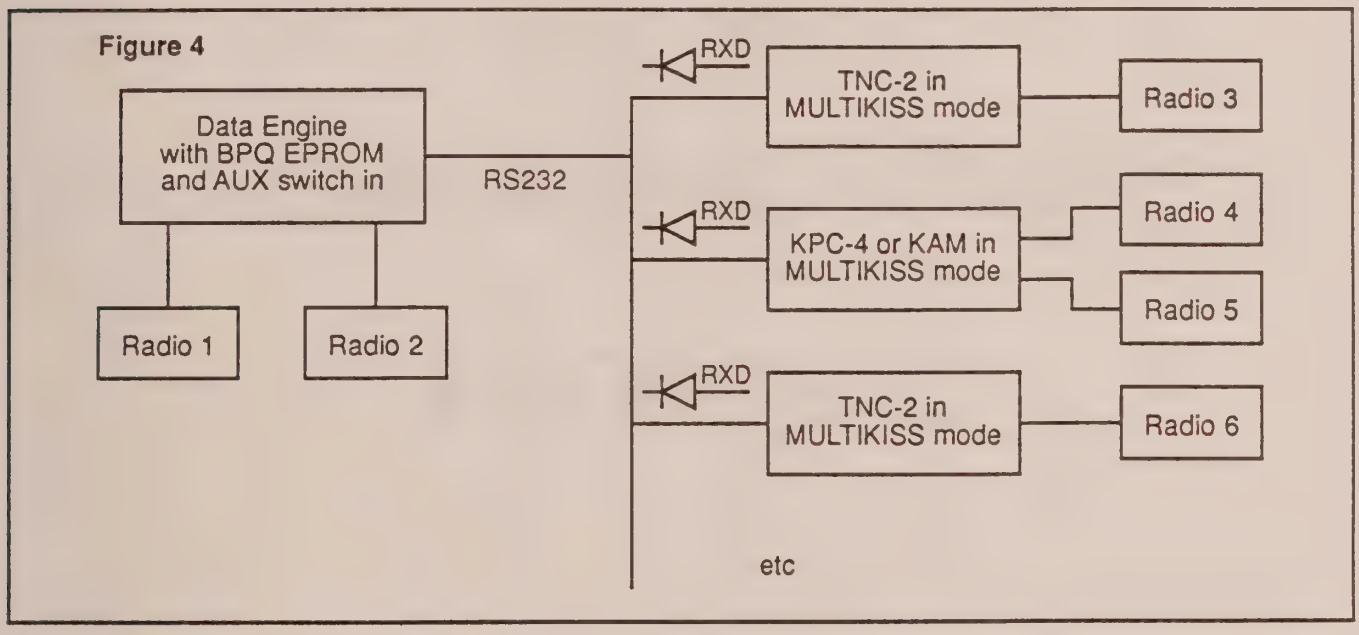
When using this method, all of the TNCs can be attached to a single serial port, such as the serial port of the Data Engine. A single diode is connected in the RXD line of each TNC, with the anode connected to the TNC and the cathode connected to the serial port of the com-

puter or Data Engine. The BPQ code in the computer or Data Engine then polls each TNC in turn (by address) for information, and the TNC then responds with any data that it has received from its associated radio. No data is sent by the TNCs to the host computer or Data Engine without being polled, so there is no conflict in data on the serial line.

Using this multi-drop kiss method, a possible configuration for a multi-port Network Node could look similar to the one shown in figure 4. Using this method, it is theoretically possible to have one Data Engine with BPQ code (2 radio ports) connected to as many as 16 other TNCs using the multi-drop KISS code, each connected to its own radio. You could conceivable mix and match all makes of TNCs, including the KAM and KPC-4 (which each would use 2 addresses and connect to 2 radios).

In this type implementation however, I suggest connecting the busiest radio channels directly to the Data Engine radio ports, since all other TNCs are polled for data, thus possibly slowing them down slightly.

This seems like a possible way to finally begin to improve our Network efficiency at a reasonable cost, and maintain the flexibility to expand to even higher speeds or new modems as they become available. The open architecture of the Data Engine will certainly lead to the development of other firmware/hardware, and perhaps we can again make packet a viable means for communication in real-time as well as a messaging system.



SAN DIEGO COUNTY
PACKET
COMMUNICATIONS
PROPOSAL

San Diego Packet Organizing Group

BACKGROUND

For some time now it has been recognized that a stable organized packet system was needed in the area to provide reliable packet communications. Until recently, packet communications has depended upon dedicated individuals putting up personal "digipeaters" and bulletin boards to serve the amateur community. Some of these have worked very well and provided good service. The problem is that people move, change jobs, loose interest, have home problems, etc and the link or digipeater or bulletin board simply goes away. Under these conditions the packet system is in a constant state of change with no one knowing just where the next link is going to be or how to get into another area.

For these reasons many of the packet community leaders have organized and set goals that are designed to best serve the packer community. A formal meeting was held on 6 October 90 to submit the proposed plans along with the work already done. A list of the persons involved is included at the end of this proposal.

GOALS

1. DIRECTION
To develop a consensus of direction for Amateur packet radio growth in San Diego County.

2. METRO NET
Establishment of an area-wide "Metropolitan Area Network" that all San Diego County general-coverage nodes can join to form a cohesive network.

3. INTRACOMMUNITY NETWORKING
Enhancement of intracommunity networking.

4. INTERCOMMUNITY NETWORKING
Enhancement of inter-community networking to provide better data transport between San Diego and surrounding areas.

PROPOSALS

1. FELLOWSHIP
The group agrees to meet regularly, either in person or on the air, to exchange ideas, problems, and progress reports.

2. METROPOLITAN (Intra-Community) NETWORKING
SCRRBA (UHF Coordination agency) has "allocated" the simplex frequency 439.000 MHz with ± 75KHz bandwidth for packet radio use in metropolitan area networking, This bandwidth was wide enough to be used for 56kb networking, and was originally allocated for that purpose in response to a request from WB6HHV (local packet leader) and others.

In the San Bernardino/Riverside area however, this channel is in use with narrowband emissions for 9600bps. Because that mode of operation precludes the use of the channel for its original intended mode of 56kb , the 56kb experimenters have chosen to remain the nationwide frequency of 433.05MHz,

leaving the range 438.250 to 439.075MHz available for use.

We propose that 439.050MHz be used for the San Diego METRO channel at 9600bps using FSK (K9NG or G3RUH) emissions. This will operate within the SCRRBA allocation yet will cause no interference to Riverside/San Bernardino metro use.

As a first step we propose to add METRO capability to the Otay and Lyons nodes. This will remove the need for forwarding between those two sites on 2 meters, and will provide 8 times the bandwidth for access to the 4800bps Otay 6 meter intercommunity (WAN) link.

Later, other nodes around town should add METRO capability to improve local data exchange. It is important that ALL nodes on the METRO be able to communicate directly with one another, not only to eliminate the waste of bandwidth that occurs when packets have to be forwarded, but also to prevent the extreme degradation of throughput that occurs when hidden terminals exist on a network.

We'd like to urge the Palomar Amateur Radio Club to upgrade their equipment from a simple digipeater to a full node, and to add it to the METRO network.

It is conceivable that high-volume data sources or sinks other than nodes could participate in the METRO directly, assuming that they can be configured so as to avoid hidden terminal problems on the METRO.

Higher speed network access is an advantage that we do not currently enjoy. In keeping with the philosophy that user access channels belong primarily on 2 meters, it is proposed to replace the Otay 145.01MHz node with a 9600bps node on 144.99, Also K6KGS on 145.09 would be changed to WB6WLV (SANDRA call).

The majority of San Diego network nodes are clustered on 145.05MHz. By shifting one or two of these to other channels, the huge number of collisions that waste a major proportion of potential channel bandwidth can be achieved. No access to any resource will be lost, since all nodes can be reached via the METRO, which is anticipated to have adequate bandwidth for the near future.

It is anticipated that the METRO can be upgraded in a few years to 56kb as packet usage increases, and as TNCs capable of handling that bandwidth become available. (Current TNCs have a maximum throughput equivalent to about 4800bps, even when interfaced at 9600bps. The processors simply aren't able to switch packets faster than that. Only the Kantronics DE56 and AEA PS-186 show the promise of being able to perform at 56kb today, and software for those devices is not yet being shipped.)

Finally, it is anticipated that a set of recommended TNC parameter settings can be developed that will maximize the usable bandwidth of packet channels in the area. These settings should be publicized and made available to ham radio vendors in the area so that they can provide their customers with the optimum settings for the many packet parameters. It is the sad truth that the manufacturer's default settings for TNCs are often based on historical usage rather than any rational evaluation of the alternatives.

3. INTER-COMMUNITY NETWORKING

Currently much of the data transmission between San Diego and other areas takes place on the California 6 meter backbone, through the Otay node. A fair amount takes place on user access channels, particular 223.42MHz. This is more by accident than planning, as for many of the stations reached on 220MHz an alternate path on 6 meters exists. By judicious use of route lockouts, inter-community traffic can be directed over the 6 meter backbone, which has a higher bandwidth. Additionally, work is underway to expand the limits of the backbone. A project yo extend it to the Bay Area is in progress, and may be completed in the early weeks of 1991. A proposal to extend it eastward across the desert to Arizona should be examined and pursued if practical.

To this end, several 6 meter radios were obtained and work is underway to set them up for participation in the backbone. If enough additional equipment can be obtained to add 6 meter backbone capability to one or two of the outlying nodes, those can become links between the metropolitan nodes and other communities.

Initially, adding 6 meter capability to the Laguna/Monument Peak node would be the first step in linking across the desert to Arizona.

Appendix
Suggested San Diego Node Configurations

Otay Mountain WB6WLV (San Diego County Packet Hub)
METRO 439.05
6 meter backbone 51.12 4800bps "Intra City" (existing)
144.99 9600 bps
145.09 1200bps (now 145.01)

Lyons Peak WB6WLV
METRO 439.05
145.01 1200bps (existing)
223.42 1200bps (existing)

Palomar Mountain W6NWG
145.05 1200 bps (convert digipeater to node) (existing)
METRO 439.05

San Miguel Mountain AA4CD
METRO 439.05
145.61 1200bps (when channel becomes avail.) (presently on 145.05)

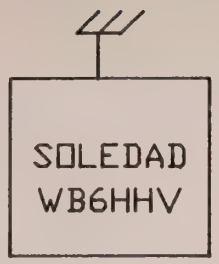
Laguna MOuntain/Monument Peak KA6DAC
METRO 439.05
6 meter link to Arizona 51.12 4800bps
145.05 1200bps (existing)

Rattlesnake Ridge (Santee/El Cajon area) (WA6BGS requested)
METRO 439.05
145.03 1200bps

Mt Soledad WB6HHV
METRO 439.05
144.xx (waiting for frequency) (proposed)

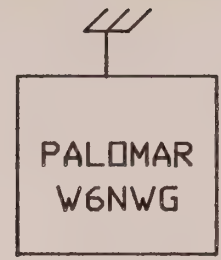
AA6QN
METRO 439.05
145.01 1200bps
BBS
GATEWAY

SAN DIEGO COUNTY PACKET SYSTEM



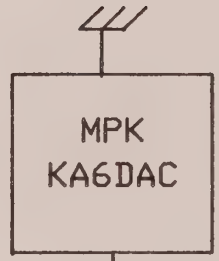
144.XXX 1200BPS USER
439.05 METRO 9600

439.05 METRO 9600
145.01 1200 USER
HF GATEWAY
BBS/MAILBOX



439.05 METRO 9600
145.05 1200 USER

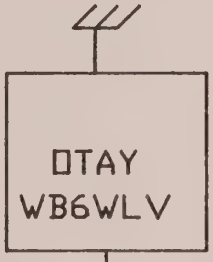
439.05 METRO 9600
145.03 1200 USER



439.05 METRO 9600
51.12 INTRACITY
145.05 1200 USER

51.12

TO ARIZONA



439.05 METRO 9600
51.12 INTRACITY
144.99 9600 USER
145.09 1200 USER
COMPUTER CONTROL
BBS/MAILBOX

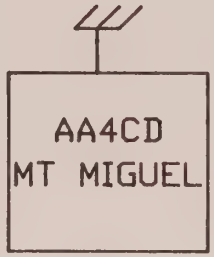
51.12 4800

TO ELSINOR

TO BIG BEAR

LA/FRAZIER

TO ARIZONA VIA MPK



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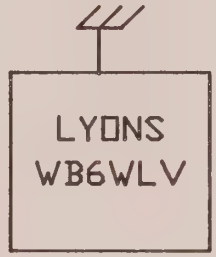
145.61 1200 USER



439.05 METRO 9600
145.01 1200 USER
223.42 1200 USER

PROPOSED CONFIGURATION OF RATTLESNAKE RIDGE NODE

1. 145.03MHz 2 meter transceiver
2. 439.05MHz 70cm transceiver
3. 2 Packet TNCs (PK88 or MFJ-1270 series)
4. 2 NET/ROM chips for TNCs (proposed WA6BGS-1 and -4)
5. 1 Dual band omni antenna, Diamond 144/440 MHz
6. 1 Duplexer network for antenna (splits output to radios)
7. 1 VHF bandpass cavity (interference and intermod suppression)
8. 1 UHF bandpass cavity (interference and intermod suppression)
9. 40 ft Belden 9913 low loss cable
10. Power Supply (adequate to run 220 machine and Packet equipment)
11. Misc. hardware, connectors, ties screws, nuts, etc

The Otay Mountain Packet Switch

by

Brian Kantor, *WB6CYT*

The WB6WLV-10 Amateur Packet Radio switch on Otay Mountain in southern San Diego County Is the most advanced networking facility available to hams in Southern California. Sponsored by SANDPAC, the San Diego Packet Radio Association (in cooperation with SANDRA, the San Diego Repeater Association), the new switch has greatly enhanced packet radio operation in the San Diego area.

User access is via duplex digital repeater at 9600 and 1200 bps on the two-meter band, plus a high-speed port at 56,000 bps on 70cm. The switch also provides AX.25, NET/ROM™ and TCP/IP connectivity to the California Intercity Trunking (CIT) and San Diego Metropolitan Area networks.

A bit of history

Early in the development of amateur packet radio, it became clear that simple keyboard-to-keyboard operation in the style of RTTY was only the most elementary use to which the newfangled packet radio could be put. Since packet provided hams for the first time ever with an error-free digital communications channel, messages could be sent from originator to recipient without a great deal of human intervention. But the range wasn't very good.

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A decade later, digipeaters are still (unfortunately) with us, but more sophisticated networking schemes have come into use. The original AX.25 implementors' idea for an internetworking scheme inside the AX.25 protocol hasn't come to pass, but TexNet, NET/ROM, ROSE, and TCP/IP have all made their mark in the ham networking world. The Otay switch accomodates several of these.

What's up there

The new switch is a seven-foot rack of equipment running off a battery-backup power supply. It is built around the Gracilis *PackeTen* advanced networking switch (their 5-port standalone model). Attached to the switch are a 56kb/s radio modem and commercial radios for the 2m repeater, and the Metro and CIT links. There is a remote control system with environmental sensors. A set of cavity filters and an antenna duplexer complete the installation. The five ports – named *lan56, metro, cit, rpt96,* and *rpt12* – are described below.

The Gracilis switch is a compact board featuring the Motorola MC68302 Advanced Communications Controller chip, 512kb of dynamic RAM, 32kb of EEPROM, an 8530 serial controller, and 256kb of program EPROM. It directly generates the packet bitstreams; only a modem is needed to modulate and demodulate the signals on the radios – no conventional TNC is used.

The primary user interface to the switch is through its attached duplex digital repeater, discussed below.

The Metro and CIT link transceivers are commercial Motorola transceivers attached to modified K9NG/TAPR direct-FSK modems. The Metro link operates at 9600 bps in the 70cm band, running about 12 watts to a somewhat-directional antenna. The CIT link operates in the 6m band running about 25 watts into (currently) an omnidirectional antenna. Please note that these are linking channels; they should not be used for user access to the switch as significant degradation of the system may result.

The 56kb system is a little less conventional. The WA4DSY design is a sophisticated modem that accepts and supplies a bitstream at one end, and generates and receives a 29 MHz radio signal at the other end. The 29 MHz intermediate frequency is then transverted to the channel frequency (currently 433.050 MHz). The DSY modem uses a modulation technique called Minimum

Shift Keying to reduce the amount of spectrum it consumes balanced against reasonable cost and complexity. At the 56kb rate, an MSK modem is about 75 kHz wide. The 56kb antenna is a horizontally polarized yagi directed roughly towards downtown San Diego. Unfortunately, we are experiencing periods of extreme degradation of the 56kb channel because of interference from radar. It may become necessary to move to another frequency.

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However, instead of a conventional audio path between the receiver and transmitter, there is a digital remodulator that decodes the incoming signal (at either 1200 or 9600 bps), and regenerates the digital FSK on the associated transmitter. There are two reasons for doing this: it promotes better reception by packet stations, since they need only adjust their receivers to one transmitter's modulation characteristics, and it discourages use of the system by FM voice stations.

Besides repeating the received digital signal, the repeater's demodulators (there are two: one for 1200 bps and one for 9600 bps) feed the received data to ports on the Gracilis switch, so that users can connect to the switch while using the repeater. Similarly, the switch has access to the companion modulators to allow it to communicate with repeater users, to send beacons and broadcasts, and to identify the system using undirected packets.

Unlike other networking systems with which the reader may be familiar, it is NOT necessary to connect to the switch when conversing with another packet station on the repeater. After a user sets his packet station to receive on 145.36 MHz, and transmit on 144.76 MHz ("down 600"), connection and conversation seem exactly as though they were taking place on a conventional simplex channel even though packets are being repeated. The difference is that every station conversing on the channel also hears the transmitted packet at the same time as well, and will not transmit on top of it. The largest single killer of amateur packet radio bandwidth is the *hidden station** problem; the repeater completely eliminates that cause of collisions.

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First you must determine whether you need to connect to the switch. If the station you wish to contact is operating on the repeater at the same baud rate as you are (1200 or 9600), you can just connect to that station – you need **not** connect to the switch. Just use the repeater.

However, if the station you want to connect to is reached via a NET/ROM node, or is on another port of the switch, or you want to make use of the other facilities of the Gracilis switch, you'll need to connect to one of the user ports of the switch.

If you are connecting directly (using simple standard AX.25) on the 1200 bps or 9600 bps repeater, or on the 56kb port, you should connect to **WB6WLV-10** or to the alias **OTAY**. You must then send at least one blank line to get the switch's command interpreter started; if you enter a command *before* you have entered the blank line, it will be ignored.

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TCP/IP users should telnet to host OTAY.AMPR.ORG, IP address 44.8.0.100. By default, the switch routes all 44.8 subnet traffic to the 1200 bps repeater port; if you are connecting on the 56kb or 9600 bps ports, you must first (and periodically) broadcast a RIP packet on that port so that the switch can learn which port to use to route to your station. Once connected, you will be prompted to enter your callsign as a login.

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Using the Otay Packet System

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If you are connecting directly (using simple standard AX.25) on the 1200 bps or 9600 bps repeater, or on the 56kb port, you should connect to **WB6WLV-10** or to the alias **OTAY**. You must then send at least one blank line to get the switch's command interpreter started; if you enter a command *before* you have entered the blank line, it will be ignored.

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TCP/IP users should telnet to host OTAY.AMPR.ORG, IP address 44.8.0.100. By default, the switch routes all 44.8 subnet traffic to the 1200 bps repeater port; if you are connecting on the 56kb or 9600 bps ports, you must first (and periodically) broadcast a RIP packet on that port so that the switch can learn which port to use to route to your station. Once connected, you will be prompted to enter your callsign as a login.

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First you must determine whether you need to connect to the switch. If the station you wish to contact is operating on the repeater at the same baud rate as you are (1200 or 9600), you can just connect to that station – you need **not** connect to the switch. Just use the repeater.

However, if the station you want to connect to is reached via a NET/ROM node, or is on another port of the switch, or you want to make use of the other facilities of the Gracilis switch, you'll need to connect to one of the user ports of the switch.

If you are connecting directly (using simple standard AX.25) on the 1200 bps or 9600 bps repeater, or on the 56kb port, you should connect to **WB6WLV-10** or to the alias **OTAY**. You must then send at least one blank line to get the switch's command interpreter started; if you enter a command *before* you have entered the blank line, it will be ignored.

If you are connecting from another node via NET/ROM, the blank line is not necessary.

TCP/IP users should telnet to host OTAY.AMPR.ORG, IP address 44.8.0.100. By default, the switch routes all 44.8 subnet traffic to the 1200 bps repeater port; if you are connecting on the 56kb or 9600 bps ports, you must first (and periodically) broadcast a RIP packet on that port so that the switch can learn which port to use to route to your station. Once connected, you will be prompted to enter your callsign as a login.

Otay Switch Commands

Once you have connected to the switch, the following commands are available to you:

[B]ye • The bye command causes the switch to close the current connection to you.

[C]onnect • Connect is followed by a callsign, or by a port name and a callsign. If the port number is specified, an AX.25 connection is attempted to the specified callsign upon the specified port. If the port name is NOT specified, the action depends upon whether the callsign given is in the Nodes routing table or not. If a known node was given as the callsign, a NET/ROM connection is attempted to that node. If the callsign was *not* in the nodes list, an attempt to connect is made on the default 1200 bps repeater port. Entering the escape character (normally control-X, see below) will abort a connection is progress or one that has been established. If the connection was established, you will be disconnected from the switch as well as the distant station. See the Xconnect command for an alternative to this action.

[CONF]erence • The conference command (which may only be abbreviated to CONF) will connect you to the roundtable conference bridge. There are a set of conference bridge commands once you are participating in the roundtable; enter /Help while in the bridge to learn them.

[E]scape • This allows you to change or eliminate the escape character, normally the control-X. "Escape none" will disable the escape character completely; to break a connection when the escape character is disabled, either your station or the distant station must initiate a disconnect. The escape character should be disabled if you are transferring data which might contain that character.

[H]elp • Gives a brief list of commands.

[I]nfo • Lists the current information file a page at a time. This file is stored in the switch's dynamic memory; if the switch is reloaded, the file will be cleared and a short default message will appear. You may wish to check the info file from time to time to learn about new switch features, bulletins, or current problems.

[J]heard • Lists the stations heard by the various switch ports in the recent past. If followed by a port name, lists only the stations heard on that port.

[N]odes • Lists NET/ROM and compatable nodes known to the switch. Nodes * lists all nodes, even those prefixed with a sharp ("#") that would ordinarily remain hidden. If the nodes command is followed by a station callsign or alias, the routing to that node will be shown.

[P]orts • Lists the currently-attached ports of the switch and some information about them.

[R]outes • Lists the NET/ROM and compatable neighbors from which the switch has heard routing broadcasts recently, and the ports and routing qualities assigned to those neighbors. The notation "locked" means that the neighbor has been manually entered by the switch manager to force or override automatic routing, which may be providing faulty data.

[T]elnet • Telnet is followed by the IP address (in dotted decimal form, e.g., 44.8.0.100) of the station you wish to telnet to. The switch must be able to ARP for or route to the station or the connection will fail.

[U]sers • Lists current users of the switch and what they're doing.

[UP]time • Lists how long the switch has been operating since its last restart. Typically NET/ROM routing data will be incomplete until the switch has been up for at least an hour.

[X]connect • Just like the Connect command, except that when connections are knocked down or are aborted, the user remains connected to the switch.

NET/ROM for the TNC-2
Amateur Radio Version 1
May, 1987

The NET/ROM software was written by Ronald E. Raikes, WA8DED. Concept, design, and documentation by Michael D. Busch, W6IXU.

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2.4. Deferred disconnect logic

When two stations are connected to one another via NET/ROM and one of the stations disconnects, NET/ROM automatically maintains its connection to the other station until all in-transit information frames have been successfully delivered to that station. NET/ROM disconnects only after all in-transit information has been delivered, or after 15 minutes has elapsed without any "forward progress" in delivering such information.

2.5. Multi-channel capability without special hardware

NET/ROM supports multi-frequency operation without the need for exotic multi-port digipeater hardware. A dual-channel node, for example, consists simply of a pair of standard TNC-2s (with NET/ROM in each) connected together with a simple RS232 cable. Configuring a NET/ROM node for three or four channels is almost as easy a TNC-2 is used for each frequency, and the multiple TNCs are interconnected via their RS232 ports using a simple diode-matrix coupler.

In addition, it is possible to configure a dual-channel NET/ROM node in which the two TNC-2s are not co-located. Instead of an RS232 cable, the TNC interconnect can employ a dedicated telephone line or even a satellite link. Because NET/ROM uses an asynchronous variant of AX.25 over the interconnect, it is not necessary that it be an error-free connection. This opens up fascinating possibilities, such as a satellite-linked dual-channel node accessible from both Washington, DC, and San Francisco, CA! Automatic adaptive routing

NET/ROM automatically takes care of the routing of traffic between one node and another. A user needs to specify just the desired destination, not the route. Each node keeps track of the other nodes in the network and the various possible paths that may be used to reach them. If a node or path becomes unusable due to equipment failure or poor propagation, NET/ROM automatically switches to an alternate route (if available) to circumvent the outage. Conversely, when a new node is placed on-line, other nodes automatically incorporate the new node into the network routing structure. Such routing changes are handled dynamically, without disrupting user connections in progress.

2.6. Local, remote, and automatic routing updates

NET/ROM supports three methods of updating its routing information: local, remote, and automatic. Initial routing information may be entered manually by an on-site operator using a local terminal. Routing changes may be made remotely by a control operator over an ordinary packet radio connection a randomized verification algorithm effectively prevents changes by unauthorized operators. In addition, NET/ROM nodes broadcast routing information to each other on an hourly basis, thereby enabling the network to incorporate new nodes and to bypass outages in real-time without manual intervention.

2.7. Mnemonic node identifiers

Each NET/ROM node is identified in two ways: by a valid amateur callsign permanently encoded into each copy of NET/ROM, and by an arbitrary mnemonic node identifier established by the node's control operator. Identifiers may be up to six characters long three-letter city designators used in aviation (LAX, SFO, CHI, NYC, PHL, DCA, ATL, JAX, etc.) are a possible choice. Mnemonic node identifiers appear in node station identification beacons, and are passed to other nodes during hourly automatic routing broadcasts. The node identifier may be used in lieu of the node callsign in most contexts.

2.8. Very easy to use and learn

Despite its internal sophistication and advanced networking capabilities, NET/ROM is exceptionally easy to

use. A novice user needs to learn only one command, CONNECT, to establish crosslinks to other nodes or downlinks to other user stations. More sophisticated users may wish to use the NODES command to list the callsigns and identifiers of other network nodes, and the USERS command to find out who else is using the node.

Control operators can use SYSOP to validate their control operator privileges, NODES to make manual changes to the routing table, IDENT to establish a mnemonic node identifier, PARMS to set or display various node parameters, and RESET to warm-start the NET/ROM firmware.
Compatible with existing digipeaters

Each NET/ROM node also supports the functions of an ordinary AX.25 digipeater. Users need not make use of the high-level networking functions of NET/ROM unless they want to. Digipeater owners can upgrade their sites to NET/ROM nodes without disrupting users. Multi-channel NET/ROM nodes provide multi-port digipeating as well. Mnemonic node identifiers may be used in lieu of node callsigns when specifying a digipeated path.

3. A Usage Example

You are KA6PRE ("Packet Radio Enthusiast") located in San Diego, and you want to access the W0RLI bulletin board system in Santa Cruz (near San Francisco). From past experience, you know that a digipeated AX.25 connection requires four digipeaters and is practically unusable. The local W6AMT-4 digipeater on 145.01 was recently upgraded to a NET/ROM node, however, so this time you decide to try using the high-tech method.

First, you establish an uplink to your local node, using the normal connect command provided by your TNC. To connect, you can use either the node's callsign "W6AMT-4" or its mnemonic identifier "SAN":

```
^C
cmd: CONNECT SAN
*** CONNECTED to SAN
```

Next, you ask the local node for a list of other NET/ROM nodes for which it has routing information, using the NODES command:

```
NODES
SAN:W6AMT-4} Nodes:
LAX:W6AMT-3 SBA:W6AMT-2 PRB:W6AMT-1 PRB2:W6AMT-11 SFO:W6AMT
SFO2:W6AMT-10 WWORM:WB6FFC-1 EWORM:WA3YMH-1 RBL:W6AMT-7
ONT:AA6TN-1 LAS:K7WS-1 PHX:WB7BNI-1
```

You know that SFO:W6AMT serves the San Francisco area (it was always the last digipeater you used to reach W0RLI via AX.25), so you ask your local NET/ROM node to connect you there (you can use either W6AMT or SFO):

```
CONNECT SFO
SAN:W6AMT-4} Connected to SFO:W6AMT
```

You are now talking to the San Francisco node, and you could issue another NODES command to see a list of other nodes that it knows how to reach. In this case, you simply want a connection to the W0RLI BBS, so you ask for it:

```
CONNECT W0RLI
SFO:W6AMT} Connected to W0RLI
```

```
Hello Fred, welcome to W0RLI BBS at 0532z
KA6PRE-15 de W0RLI>
etc.
```

Note that the downlink from W6AMT to W0RLI has been made using your callsign (KA6PRE), but with the SSID suffix changed from -0 to -15. (More about this later.)

At the end of your session with W0RLI, you disconnect your TNC as usual:

```
^C
cmd: DISC
*** DISCONNECTED
```

When you disconnect, NET/ROM automatically takes care of disconnecting your circuit to SFO:W6AMT and your downlink to W0RLI.

4. Theory of Operation

4.1. Some Definitions

Following are definitions of some terms that are used in describing the operation of NET/ROM.

User Any amateur packet radio station using AX.25 protocol. In the context of this document, a BBS or other automated server is considered a "user".

Digipeater A station capable of digitally repeating AX.25 frames as specified in the AX.25 protocol specification. Generally, refers to an unattended, wide-coverage digital repeater, often located on a hilltop.

Node A packet radio station utilizing TNC-2 hardware executing NET/ROM firmware. Generally, refers to an unattended, wide-coverage station, often located on a hilltop.

Dual-Channel Node A pair of NET/ROM nodes operating on two different frequencies, and coupled together by means of an RS232 cable.

Multi-Channel Node Three or more NET/ROM nodes operating on different frequencies, and interconnected via their RS232 ports using a diode-matrix coupler.

Link An AX.25 connection involving a node at one or both ends. Node-to-node links always use AX.25v2 protocol. User-to-node links use AX.25v2 protocol if the user's TNC supports it, otherwise AX.25v1.

Uplink An AX.25 connection between a user and a node, initiated by the user. An uplink is usually a direct connection, but may be digipeated if necessary.

Downlink An AX.25 connection between a node and a user, initiated by the node. A downlink is usually a direct connection, but may be digipeated if necessary. A downlink is established by a node at the behest of a user (in response to a CONNECT command).

Crosslink An AX.25 connection between two adjacent nodes. A crosslink is usually a direct connection, but may be digipeated if necessary. A crosslink between two nodes is initiated by one of the nodes when first establishing a circuit which traverses the route segment between the two nodes. One crosslink can carry any number of circuits, so it is never necessary to have more than one crosslink between any pair of nodes.

Circuit A transport-layer connection between two nodes, established by one of the nodes at the behest of a user (in response to a CONNECT command). The two nodes are not necessarily adjacent, and may be quite distant. The circuit is automatically routed through intermediate nodes as necessary, and carried from node to node over crosslinks (which are initiated if not already established).

4.2. Making Connections

Suppose you are a user with access to a local node, and you want to contact another user station who is also within range of the same node. You can, of course, connect to the other station "the old way" by using the node as a digipeater. To take advantage of the store-and-forward capabilities of the node, however, you would use this two-step procedure: (1) connect to the node ("uplink"); then, (2) issue a CONNECT command with the callsign or mnemonic identifier of the other user station ("downlink").

4.2.1. Uplink-Downlink Connection

All AX.25 frames include the callsigns of both the originating station and the destination station. When you request a downlink, the node "adopts" your callsign as the originating station (rather than using its own callsign). This is necessary so that the destination station can properly identify you as the connecting user station, and is especially important when the destination is a mailbox, gateway, or other automated server.

Well...that's not exactly the way it works! If the node truly did "adopt" your callsign, and if there also happened to be a direct path (however marginal) between your station and the destination station, that station would then be "in range" of two stations using the same callsign. This can create serious confusion, AX.25-protocolwise!

To avoid this problem, the downlinking node "adopts" your basic callsign, but changes the SSID (the "-N" callsign suffix) from N to 15-N. For example, if your callsign is K6AAA, the downlink uses K6AAA-15; if your callsign is W3ABC-2, the downlink uses W3ABC-13; and so forth.

Now, suppose you want to contact a user station that can't copy your local node, but is in range of another node that serves his area. Once again, you could use "old-style" multi-hop digipeating to reach him (since every node is also a digipeater). To utilize the full store-and-forward capability of the nodes, however, you would use a three-step procedure: (1) connect to your local node; then, (2) issue a CONNECT command with the callsign or mnemonic identifier of the distant node; finally, (3) issue a CONNECT command with the callsign of the other user station.

4.2.2. Uplink-Crosslink-Downlink Connection

When you perform step (2) of this procedure, you are asking your local node to create a "circuit" for you between your local node and the distant node. If the two nodes are sufficiently far apart, the circuit may have to pass through several intermediate nodes. In any case, the routing is performed automatically by the node. Your circuit is carried by a series of AX.25 "crosslinks" between pairs of adjacent nodes. In all likelihood, the necessary crosslinks are already established when you issue your CONNECT command (one crosslink can carry many circuits); if not, then the necessary crosslinks are set up. All of this crosslinking stuff happens automatically and transparently you needn't worry about it, but it's interesting to know what's going on up there on the hilltops!

Dual- and Multi-Channel Operation

To realize the full potential of NET/ROM's high-level networking capabilities, it is an excellent idea to minimize interference between local (uplink/downlink) and long-haul (crosslink) traffic. One good way to accomplish this is to reserve one radio frequency exclusively for inter-node traffic, to provide end-user access to the nodes on one or more separate frequencies, and to discourage (ideally, to prevent) end-users from using

the inter-node "backbone" frequency. This approach requires network nodes that can access two or more frequencies.

4.2.3. Creating a "Backbone" Utilizing Dual-Channel Nodes

NET/ROM supports such multi-channel operation without the need for exotic multi-port digipeater hardware. A dual-channel node, for example, consists simply of a pair of standard TNC-2s (with NET/ROM in each) connected together with a simple RS232 cable. Each TNC takes responsibility for handling traffic on a single frequency; cross-frequency traffic is passed over the cable between TNCs at relatively high speed. (See installation instructions for wiring of the inter-TNC cable.)

Configuring a multi-channel NET/ROM node for three or more channels is almost as easy as dual-channel operation. A TNC-2 with NET/ROM installed is used for each frequency. Once again, the TNCs are interconnected via their RS232 ports. Interconnecting three or more TNCs requires nothing more elaborate than some isolation diodes. (See installation instructions for details.)

4.3. Digipeating vs. Store-and-Forward

The AX.25 protocol was originally designed for point-to-point (non-digipeated) connections. AX.25 was subsequently extended to accomodate one digipeater, and later extended again to allow up to eight digipeaters.

As all experienced packet radio users know, however, AX.25 is practically unusable for communications on paths exceeding two or three "hops". The reason for this is that AX.25 digipeaters do not participate in error control. For an AX.25 packet to traverse a multi-hop path, it must not fall victim to a collision or other error during any of the hops; otherwise, it must be retransmitted by the originating station and start its journey all over again.

The probability that an AX.25 packet can complete its journey successfully deteriorates rapidly as the number of hops increases. For example, it takes five hops (four digipeaters) to get from San Diego to San Francisco. If the average reliability per hop is 90% (which may be optimistic in those congested areas), then the probability that a packet will traverse the five-hop path unscathed and be successfully acknowledged (which requires ten error-free hops) is less than 35%. In other words, it will take an average of 2.9 tries to get the packet through successfully. Since the usual timeout threshhold for a five-hop path is 36 seconds, the average elapsed time to get the packet through will average about 77 seconds! [This assumes a 10% error probability per hop, and the usual 1200-baud timeout of 4*(2*digis+1) seconds.]

Using NET/ROM nodes instead of ordinary AX.25 digipeaters changes this situation dramatically for the better. When the San Diego user transmits a packet destined for San Francisco, it is received by the local NET/ROM node serving San Diego. That node immediately passes the packet to its neighboring node to the north, and sends an acknowledgement back to the user. This process is repeated five times in all. Whenever a packet is lost due to collision or other error, recovery is handled by just the two adjacent nodes involved.

As a result, the average elapsed time to get a packet through decreases to less than 10 seconds, about an 800% improvement in throughput. [Same assumptions as previous example.] For longer paths, the payoff is even more dramatic.

4.4. Organization of the Firmware

The NET/ROM firmware is composed of eight major modules organized closely along the lines of the seven-layer ISO reference model.

4.4.1. Serial I/O Drivers (L1a & L1b)

At the lowest level are interrupt-driven device drivers for the two serial I/O channels of the TNC-2 hardware. The HDLC driver (L1a) manages the SIO-A port which is connected to the TNC's AFSK modem, while the RS232 driver (L1b) manages the SIO-B port which is connected to the TNC's RS232 host port.

The RS232 driver determines whether the RS232 port is attached to a terminal or to one or more other TNCs by looking at DCD-B (wired to RS232 pin 23, as described in the installation instructions). If a terminal is attached, the RS232 driver interfaces with the Host Interface module (solid arrows); if another TNC is attached, the RS232 driver interfaces with the Link Manager (dotted arrows).

4.4.2. Link Manager (L2)

The Link Manager manages all AX.25 links (uplinks, downlinks, and crosslinks), and maintains a link table to keep track of currently-active links. This module includes most of the capabilities of a normal AX.25 TNC, including digipeating.

The AX.25 protocol provides for a "Protocol Identification" (PID) field in the header of information frames. NET/ROM identifies information that it sends over node-to-node crosslinks with a special PID value ('CF'), while information sent to or from users over uplinks and downlinks use the standard PID value ('F0'). The Link Manager passes incoming inter-node 'CF'-frames to the Routing Manager, whereas it passes incoming user 'F0'-frames directly to the Data Switch.

The Link Manager monitors traffic on each active AX.25 link. If no information has been passed over a particular link for 15 minutes, that link is automatically disconnected.

4.4.3. Routing Manager (L3)

The Routing Manager maintains the routing table, and handles the automatic routing of crosslink traffic. It examines the network header of arriving frames to determine the callsign of the destination node. If a frame is destined for this node, it is passed to the Circuit Manager. Otherwise, the routing table is searched for the destination node, the next node along the route to that destination is determined, a crosslink to that node is established if none already exists, and then the frame is passed back to the Link Manager for crosslinking.

The Routing Manager also facilitates manual and automatic updates to the routing table. It supports the manual update capabilities of the NODES command, which can be used locally or remotely by an authorized control operator. It also issues automatic hourly routing broadcasts, and analyzes broadcasts received from other nodes to see if automatic routing table updates are needed.

4.4.4. Circuit Manager (L4)

The Circuit Manager handles the initiation, disconnection, and end-to-end error and flow control for transport-layer circuits between nodes, and maintains a circuit table to keep track of currently-active circuits.

The Circuit Manager receives incoming frames from the Routing Manager. It analyzes the transport header of each frame, using a "sliding window protocol" to detect missing, duplicate, and out-of-sequence frames. It enforces circuit-layer flow control to protect the network against disproportionate loading by any one circuit. After validation, the incoming frames are passed to the Data Switch. For outgoing frames, the flow is just the reverse.

New circuits are initiated only when explicitly requested by a user (via the CONNECT command). The Circuit Manager monitors traffic on each active circuit. If no information has been passed over a particular

circuit for 15 minutes, that circuit is automatically disconnected.

4.4.5. Data Switch (L7a)

The Data Switch module acts as a switchboard within the node. It maintains a table of "patchcords" which establish two-way linkages between links, circuits, the Command Interpreter, and the Host Interface.

When a user first connects to a node (via an uplink, or via a circuit from another node), the Data Switch initially connects his uplink (or circuit) to the Command Interpreter. If the user then issues a CONNECT command to request a downlink, circuit, or host connection, then the Data Switch "patches him through" as appropriate.

4.4.6. Command Interpreter (L7b)

The Command Interpreter analyzes and executes user commands, and diagnoses any resulting errors that may occur. When a user first enters a command, the Command Interpreter establishes a user task and makes a corresponding entry into its user table. The user remains in command mode (and his task remains active) until he disconnects or executes a successful CONNECT command. The Command Interpreter supports seven commands: CONNECT, NODES, USERS, PARMS, IDENT, RESET, and SYSOP.

The CONNECT command enables a user to request a circuit to a distant node, a downlink to a user station, or a direct connection to the local host terminal (if there is one) attached to the node.

The NODES command permits a user to obtain a list of other nodes for which the local node has routing information, and to examine the routing details to any particular node. It also allows an authorized control operator to add, delete, or change routing table entries manually.

The USERS command displays a summary of the current activity at the node, including information about active uplinks, downlinks, circuits, patchcords, and users in command mode.

The PARMS command displays a series of numeric node parameters, and allows an authorized control operator to change the values of these parameters. Likewise, the IDENT command displays the mnemonic identifier of the node, and allows a control operator to change it. The RESET command permits a control operator to reset (warm-start) the node remotely.

The SYSOP command allows an authorized control operator to establish his credentials prior to making privileged changes using the NODES, PARMS, or IDENT commands, or doing a RESET. SYSOP uses a randomized validation algorithm which makes it extremely difficult for an unauthorized user to masquerade as a control operator.

4.4.7. Host Interface (L7c)

The Host Interface supports a local terminal attached to the node. It permits the local terminal to access all of the same capabilities that a remote user can access. In addition, it supports some specialized "host commands" available only from the local terminal. For example, it allows local entry of the password string used by the SYSOP command to validate control operator credentials.

4.5. Flow of Information

Now, let's take a more detailed look at what is actually happening inside the node when you access the network. (Warning: this section is intended mainly for the incurable hackers in the audience. If you find the

going getting a bit difficult, just skip ahead to the next section. And don't worry about it...you don't really need to know this stuff!)

First, you connect to your local node. The Link Manager acknowledges your connect request, and makes a new entry in its link table. Since it is an uplink, incoming information frames from you are passed directly to the Data Switch. Initially, the Data Switch always patches you through to the Command Interpreter. The Command Interpreter makes a new entry in its user table, and starts interpreting your commands.

Next, you send a CONNECT command that specifies the callsign or identifier of a distant node. Your command is passed from the Link Manager to the Data Switch to the Command Interpreter. The Command Interpreter asks the Circuit Manager to establish a new circuit to the distant node. If this succeeds, then the Command Interpreter asks the Data Switch to set up a "patchcord" between your uplink and the newly-created circuit. (If the circuit cannot be established for some reason, then the Command Interpreter will tell you so.)

To set up your circuit, the Circuit Manager creates a transport-layer connect request message, and sends it to the Routing Manager. The Routing Manager uses its routing table to determine the next node en-route to the ultimate destination. There probably is a crosslink to that node already; if not, the Routing Manager asks the Link Manager to establish one. Then, the Routing Manager passes the connect request message to the Link Manager for crosslinking.

The frame is received by the Link Manager of the next node. Since it came from a crosslink, it is passed to the Routing Manager. The Routing Manager sees that the ultimate destination hasn't been reached yet, consults its routing table to find the next en-route node, sets up a crosslink if one doesn't already exist, and passes the message on. This continues until the message reaches its destination.

At the destination, the message passes from the Link Manager to the Routing Manager, and then (since it has reached its ultimate destination) to the Circuit Manager. The Circuit Manager creates a transport-layer connect acknowledge message, and passes it back to the originating node via the same snake-like path (in reverse).

Any information received over the new circuit by the Circuit Manager at the distant node is passed to the Data Switch. Initially, the Data Switch patches it through to the Command Interpreter.

Now, you send a CONNECT command that specifies the callsign of another user. Your command passes from the uplink, through the patchcord in the local node to the circuit, through the circuit (via that snake-like path through the intermediate nodes and crosslinks) to the distant node, and through the Data Switch to the Command Interpreter of the distant node.

This time, the distant Command Interpreter analyzes your CONNECT command, and asks the Link Manager to establish a new downlink to the specified user station. If this succeeds, then the Command Interpreter asks the Data Switch to set up a patchcord between your circuit and the newly-created downlink. From that point on, anything you send passes all the way to the other user station...the high-tech way! (Once again, if the downlink cannot be established for some reason, then the distant Command Interpreter will tell you so.)

4.6. Error and Flow Control

NET/ROM uses the standard AX.25v2 link-layer packet radio protocol for crosslinks between neighboring nodes, as well as for links from each node to its local users. Normal AX.25v2 error handling is used to assure error-free transmission, and normal AX.25v2 flow control is used to control network congestion.

In addition, NET/ROM incorporates a transport-layer "sliding window protocol" to provide end-to-end error and flow control for each virtual circuit. End-to-end error control is necessary to protect against lost, duplicate, or out-of-sequence frames resulting from node failures and dynamic routing changes. End-to-end flow control is necessary to protect the network against disproportionate loading by any one circuit.

The transport-layer protocol used by NET/ROM is similar in concept to the familiar AX.25, but is somewhat more sophisticated. For example, it can accept out-of-sequence frames and re-sequence them internally. It can also selectively request a repeat of a missing frame without requiring retransmission of all succeeding frames.

4.7. Deferred Disconnect

A classic problem in packet radio occurs at the end of a QSO when one station wants to disconnect, but not before making certain that the other station has successfully received the first station's concluding information frames. This often resolves itself with a last-minute flurry of closing remarks such as "SK," "EOM," "U DISC" and so forth. NET/ROM solves this dilemma in a more elegant fashion.

If two stations are connected to one another via the network and one of the stations disconnects, NET/ROM automatically maintains its connection to the other station until all in-transit information frames have been successfully delivered to that station. NET/ROM disconnects only after all in-transit information has been delivered, or after 15 minutes has elapsed without any "forward progress" in delivering such information.

4.8. Automatic Adaptive Routing

When you ask one node for a circuit to a distant node, your CONNECT command specifies the callsign or mnemonic identifier of the destination node, but the routing is handled automatically by NET/ROM. Automatic routing is handled by the Routing Manager, and is controlled by its routing table.

The routing table within a node contains a list of all other nodes "known" to the node, together with their mnemonic identifiers. You can ask to see this list by using a parameterless NODES command. The routing table can keep track of hundreds of other nodes (limited only by the size of available memory and any constraints imposed by the control operator).

If you want to connect to an especially distant node, it is possible that your local node doesn't know of it (i.e., it is not listed in the local NODES display). In this case, you can use CONNECT to obtain a circuit to a known node nearer the desired destination, and then issue another NODES command to get a list of the nodes known to that node. This process can be repeated if necessary.

For each known node, the routing table can contain up to three alternate ways to route traffic to that node. The node knows the quality of each alternate route, and always attempts to use the "best" (i.e., highest quality) route to a destination. However, if a node or path becomes unusable due to equipment failure or poor propagation, the Routing Manager automatically switches to an alternate route (if available) to circumvent the outage. Such routing changes are handled dynamically, usually without disrupting circuits in progress.

The routing table maintained by each node consists of two dynamically allocated threaded lists: the destination list and the neighbor list. The destination list contains an entry for every other node "known" to this node. (This is the the list displayed by the NODES command.) The neighbor list contains an entry for only those "neighboring" nodes to which this node has a direct link.

For each node in the destination list, the routing table up to three routes to that destination node. In this context, a route simply identifies a neighboring node that is a step closer to the ultimate destination. For each route, the destination list maintains a quality value in the range 255 (best) to 0 (worst). Routes are maintained in sorted order by quality, and NET/ROM always attempts to use the highest-quality route available. It also keeps an obsolescence count , which enables NET/ROM to purge paths from its routing table when it has become unuseable and remained so for a protracted period of time.

Observe that the routing table does not contain the entire path to each known destination (this is unnecessary, and would require too much memory), but just a list of neighboring nodes that are reasonable choices for a next step enroute to the destination. You can ask to see the routes to a particular destination node by using a NODES command that specifies the callsign or mnemonic identifier of the destination.

Routing Table Updates

Since each node keeps track of many other nodes and the available routes to those nodes, it is important that this routing information be kept up-to-date to reflect the current state of the network. NET/ROM supports three methods of updating its routing table: local, remote, and automatic.

When a node is first placed on-line, an initial set of routing information is entered manually by the control operator using a local terminal connected to the RS232 host port. The NODES command permits the control operator to add, delete, and modify any entry in the routing table.

The same manual update capabilities are available to the control operator at any time via remote control. To make routing table changes remotely, the control operator simply connects to the node, validates his control operator authority by means of the SYSOP command, and then updates the routing information using the NODES command. The SYSOP command uses a randomized verification algorithm that makes it extremely difficult for an unauthorized user to masquerade as a control operator.

To enable the network to incorporate new nodes and to bypass extended outages without the need for control operator intervention, NET/ROM also provides a mechanism for automatic update of routing information on a distributed basis. Once an hour, each node automatically broadcasts a list of all other nodes which it knows how to reach for each such node, the broadcast includes the callsign, mnemonic identifier, and the optimum route and its quality. This hourly broadcast takes the form of an AX.25 UI-frame with PID='CF'. When the broadcast is received by neighboring nodes, they automatically make any necessary additions, deletions, and modifications to their routing tables, and incorporate the revised information into their own hourly broadcasts. Thus, whenever a new node is placed on-line, knowledge of the new node automatically propagates throughout the network within a few hours. If a node or route becomes unuseable, that information also propagates automatically.

4.9. Route Quality Analysis

For each route in its routing table, NET/ROM maintains a route quality value in the range 255 (best) to 0 (worst). This allows it to keep alternate routes in order of quality, and to select the best available route to a destination.

A route quality value can best be visualized as a fraction (the value divided by 256) which quantifies the speed and reliability of a particular route in comparison to a theoretically perfect route (an infinitely fast and perfectly error-free path) of quality 256. For example, a route of quality 230 can be thought of as being "90% perfect" in speed and reliability (230/256 = 0.90).

The quality of each channel used by a NET/ROM node is established by the control operator of the node. As a starting point, we suggest the following values to be used as channel quality parameters:

Channel Description	Quality	% Perfect
9600-baud RS232 wire interconnect (2-port)	255	99%+
9600-baud RS232 satellite interconnect (2-port)	252	98%
9600-baud RS232 wire interconnect (3-port)	248	97%
9600-baud HDLC isolated internode backbone	240	94%
1200-baud HDLC isolated internode backbone	224	88%
1200-baud HDLC user-accessed channel	192	75%
300-baud HDLC HF channel	128	50%

Known loopback or route of unknown quality	0	?

The quality of a multi-segment route is simply the product of the qualities of each individual segment, where quality values are treated as fractions with an implicit denominator of 256. For example, a four-segment route that consists of two 9600-baud RS232 interconnect segments (quality 255) and two 1200-baud HDLC backbone segments (quality 224) has a calculated quality of 194 (255/256 times 255/256 times 224/256 times 224/256 equals 194/256). Quality calculations are rounded to the nearest 256th.

4.10. Station Identification

In order to conform with FCC regulations concerning station identification, each NET/ROM node identifies itself every 9 minutes and 59 seconds. The station identification is carried by an AX.25 UI-frame addressed to "ID" and containing the text "Network node" plus the node's mnemonic identifier (if it has one) in parentheses. The control operator can disable this feature, if desired, by means of the PARMS command.

4.11. Digipeating

Of course, each node also supports the functions of an ordinary AX.25 digipeater. Users need not make use of the high-level networking functions of NET/ROM unless they want to. Digipeater owners can upgrade their sites to NET/ROM nodes without notifying the user population the users won't notice any change unless they happen to monitor a station-id broadcast or try to connect to the node (expecting a "busy" message).

Furthermore, each multi-channel node is also a multi-port digipeater. Each channel is assigned a different callsign. Often, the same basic callsign will be used, but with different SSID suffixes for each frequency. (For example, N6NET-1 on 145 MHz and N6NET-11 on 220 MHz.) Cross-frequency digipeating is requested simply by including both callsigns as digipeaters (e.g., "C W6ZZZ via N6NET-1,N6NET-11,...").

If a node is assigned a mnemonic identifier, that identifier is also recognized as an AX.25 "alias". It can be used in lieu of the callsign for purposes of digipeating ("C W0RLI via LAX,SBA,MRY,SFO") or uplinking ("C LAX").

Users of distant mailboxes, gateways, and other automated servers have two options: they can connect "the old way" (via multi-hop AX.25) or "the new way" (via the uplink-crosslink-downlink procedure). Both methods will work with all existing BBSs. Auto-forwarding mailbox systems can use "the old way" until their auto-forwarding algorithms have been updated to take advantage of NET/ROM. Note that W0RLI's portable "C" bulletin board system is already capable of auto-forwarding using NET/ROM transport-layer connections.

4.12. Control Operator Validation

Authorized control operators can make manual updates to routing table entries with the NODES command, modify various node parameters with the IDENT and PARMS commands, and warm-start the node with the RESET command. To do these things remotely, a control operator must first validate his credentials by means of the SYSOP command otherwise, the RESET command and the update functions of the NODES, IDENT, and PARMS commands are locked out.

Because packet communications between the control operator and the node can be easily monitored (and imitated) by any user, an ordinary password scheme cannot provide effective validation. Consequently, the SYSOP command utilizes a randomized validation algorithm that makes it quite difficult for an unauthorized user to masquerade as a control operator.

Here is how it works. A password string up to 80 characters long is entered into the node by an on-site

operator via a local terminal. (Obviously, the password string cannot be changed remotely.) When a remote operator enters the SYSOP command, the node replies with a list of five random numbers (each in the range 1-80). The operator must then enter the five characters that correspond to those numbered character positions in the password string. The five correct characters must be entered before control operator privileges are granted.

A user who monitors this procedure can learn only five characters of the password string. He would have to monitor a large number of such procedures before he could learn enough of the password string to have any reasonable chance of a successful masquerade. To make things harder, the password string may contain non-printing control characters, if desired. To make things even harder, the command interpreter does not report whether or not a SYSOP validation procedure has succeeded or failed consequently, an especially paranoid control operator could perform two or three SYSOPs, giving false answers to all but one of them, and thereby giving misleading information to anyone who might be monitoring. (Of course, it also doesn't hurt to change the password string from time to time whenever someone visits the site...)

5. Commands

NET/ROM supports seven commands: CONNECT, IDENT, NODES, PARMS, RESET, SYSOP, and USERS. For any of them, the entire command verb ("CONNECT") or just a fragment ("CONN" or "CO" or "C") is allowed. Any command parameters must be separated from the verb and each other by one or more spaces. The maximum command length is 80 characters. Commands must end with a carriage-return.

5.1. CONNECT Command

The CONNECT command is used to request a circuit to another node, a downlink to another user, or a connection to the node's host terminal.

To request a circuit to another node, the command is:

CONNECT *node*

where node must be the callsign or mnemonic identifier of another node that is "known" to this node. (Use the NODES command to obtain a list of all known node callsigns and identifiers.) For example:

```
CONNECT WB7BNI-1
SAN:W6AMT-4} Failure with PHX:WB7BNI-1

CONNECT SFO
SAN:W6AMT-4} Connected to SFO:W6AMT
```

To request a downlink to another user, the command is:

CONNECT *usercall [[VIA] digicall,...,digicall]*

where usercall is the callsign of the user station, and digicall is the callsign (or alias) of a digipeater. If digipeaters are used, the use of "VIA" is optional ("VI" or "V" are also acceptable). Digipeaters may be separated by either spaces or commas. For example:

```
CONNECT WM6P via N6GPP-1
LAX:W6AMT-3} Busy from WM6P

CONNECT W0RLI
```

```
SFO:W6AMT} Connected to W0RLI
```

To request a connection to the node's host terminal, the command is:

CONNECT

with no parameters. For example:

```
CONNECT
SBA:W6AMT-2} Connected to SBA:W6AMT-2
```

In all cases, a successful connection is announced by the message "Connected to callsign". "Failure with callsign " indicates that the specified node or user did not respond after a number of attempts. "Busy from callsign" indicates that the node or user responded but refused the connection request.

Other possible error messages are "Node busy", "Circuit table full", "Link table full", and "Host table full". These messages indicate a lack of resources in the node the user should disconnect and try again later.

An in-process CONNECT command is immediately aborted if another command or a blank line is entered before the requested connection is established.

5.2. NODES Command

The NODES command is used to display or modify the node's routing table.

To display a list of other known nodes with their mnemonic identifiers, use NODES without any parameters:

```
NODES
SAN:W6AMT-4} Nodes:
LAX:W6AMT-3  SBA:W6AMT-2  PRB:W6AMT-1  SFO:W6AMT  RBL:W6AMT-7
ONT:AA6TN-1  LAS:K7WS-1   PHX:WB7BNI-1
```

The normal NODES display includes all known nodes in the routing table except "hidden" nodes that have mnemonic identifiers that start with the character "#". To obtain a display of all nodes including such hidden nodes, use the command "NODES *":

```
NODES *
SAN:W6AMT-4} Nodes:
LAX:W6AMT-3  SBA:W6AMT-2   PRB:W6AMT-1       #PRB:W6AMT-11
SFO:W6AMT    #SFO:W6AMT-10 #WWORM:WB6FFC-1   #EWORM:WA3YMH-1
RBL:W6AMT-7  ONT:AA6TN-1   LAS:K7WS-1        PHX:WB7BNI-1
```

To display specific routing information for a particular node, use NODES followed by the callsign or identifier of the node in question:

```
NODES PHX
LAX:W6AMT-3} Routes to PHX:WB7BNI-1
> 108  6  0 AA6TN-1
   81  6  0 W6AMT-4
```

This command shows up to three routes to the specified node. For each route, the following items are displayed:

* the symbol ">" if the route is currently in use
* quality of the route (255 is best, 0 is worst)
* obsolescence count (downcount, 0 denotes a permanent entry)
* port number (0=HDLC port, 1=RS232 port)
* path to neighboring node (callsign plus up to two digipeaters)

The NODES command also supports manual updates to the routing table, but this capability is available only to a control operator who has previously validated his credentials during this connection by successfully executing the SYSOP command. To add or delete routing table entries, the commands are:

NODES *nodecall + ident quality count port neighbor [digicall...]*
NODES *nodecall - ident quality count port neighbor [digicall...]*

The "+" version adds a new entry to the routing table; the callsign nodecall is added to the list of known nodes if it isn't already there. The ident parameter is a mnemonic identifier up to six characters long, or "*" if the node has no identifier. The quality parameter is a decimal integer in the range 255 (best) to 0 (worst) that defines the quality of the best-case route to the destination node via the specified neighbor. The count parameter is the initial obsolescence count zero denotes a permanent, unchangeable route entry. The port parameter is given as either 0 (HDLC port) or 1 (RS232 port). The neighbor and digicall parameters give a path to an adjacent node that is enroute to the destination (two digipeaters max).

The "-" version searches the routing table for an entry that exactly matches the given nodecall, port, neighbor and digicall parameters, and deletes it if such an entry is found; deleting the last route for a particular nodecall also removes it from the list of known nodes. In case of an invalid request (or a valid request by an unvalidated user), these commands are quietly ignored, not diagnosed. Examples:

```
NODES WB7BNI-1 + PHX 115 6 0 AA6TN-1
LAX:W6AMT-3} Routes to PHX:WB7BNI-1
 > 115 6 0 AA6TN-1
    81 6 0 W6AMT-4

NODES WB7BNI-1 - PHX 81 6 0 W6AMT-4
LAX:W6AMT-3} Routes to PHX:WB7BNI-1
  > 115 6 0 AA6TN-1
```

5.3. USERS Command

The USERS command displays a summary of who is using the node:

```
USERS
LAX:W6AMT-3} NET/ROM 1.0 (720)
Uplink(WA8DED)                <-->  Host(LAX:W6AMT-3)
Uplink(KA6SOX)                <-->  Downlink(KA6SOX-15 WB6YMH)
Uplink(NK6K-2)                <-->  Circuit(SBA:W6AMT-2 NK6K-2)
Circuit(SFO:W6AMT WB6ASR)     <-->  Downlink(WB6ASR-15 WD6E)
Circuit(SFO:W6AMT WB6RAL)     <-->  Circuit(PHX:WB7BNI-1 WB6RAL)
Circuit(SBA:W6AMT-2 WA6JPR)
Uplink(NK6K)
```

The heading of the USERS display indicates the version of the NET/ROM firmware in use at the node, and the amount of free RAM space (shown in parentheses, and expressed as a number of 32-byte buffer

segments).

After the heading, the USERS display shows the active circuits and links, using the following formats:

* Uplink(fromcall)
* Downlink(fromcall tocall)
* Circuit(othernode usercall)
* Host(thisnode)

The "<-->" symbols represent active "patchcords" in the node that connect uplinks, downlinks, circuits, and possibly the host terminal (if any). The lines which do not contain the patchcord symbol represent users who are in command mode at the node.

5.4. SYSOP Command

The SYSOP command allows an authorized control operator to establish his credentials prior to making privileged changes using the NODES, PARMS, or IDENT commands, or executing a RESET command. It uses a randomized validation algorithm, in conjunction with a "password string" previously entered via the node's host terminal. The command is simply "SYSOP", in response to which the node will respond with a list of five random numbers:

```
SYSOP
LAX:W6AMT-3} 26 13 54 5 38
```

The control operator must respond by entering the five characters in the correspondingly numbered character positions of the "password string". The random numbers returned by SYSOP will always correspond to valid non-space character positions of the password string. The five required characters may be entered with or without intervening spaces, and must be followed by a carriage-return. There is no acknowledgement of success or failure.

For example, assume the password string is "The quick brown fox jumped over the lazy dog's back 0123456789 times". A valid control operator validation sequence might be:

```
SYSOP
LAX:W6AMT-3} 26 13 54 5 38
dolqa
```

where the 26th character of the password string is "d", the 13th character is "o", etc. If the validation succeeds, subsequent IDENT, NODES and PARMS update requests and the RESET command are honored; otherwise, they are quietly ignored. When accessing the node from a local host terminal, control operator privileges are automatically granted. There is no need to use the SYSOP command in this case.

5.5. IDENT Command

The IDENT command allows an authorized control operator to set or change the mnemonic identifier of the node. The command is:

IDENT *identifier*

where "identifier" is a string up to six characters long, or "*" if the node is to have no identifier at all. For example:

```
IDENT LAX
LAX:W6AMT-3} LAX
IDENT *
W6AMT-3}
```

Node identifiers should normally be composed of letters and digits only. Non-printing characters and punctuation marks are invalid (with one exception discussed in the next paragraph). Lower-case letters are converted to upper-case. In addition, NET/ROM will not accept a node identifier that "looks like" a valid amateur callsign a string of letters and digits looks like a callsign if it is between four and six characters long, has either one or two digits, and the rightmost digit is neither the first nor the last character in the string.

A node identifier may use the character "#" in its first character position. This causes the node to be supressed from the NODES displays at other nodes. (NOTE: The use of other punctuation characters in node identifiers is reserved for possible future extensions of NET/ROM.)

Before using the IDENT command to change the node identifier remotely, you must validate your credentials as a control operator by using the SYSOP command...otherwise, the node identifier is left unchanged.

5.6. PARMS Command

The PARMS command can be used to display or change various numeric parameters that affect operation of the node. To display the node parameters, use PARMS with no parameters:

```
PARMS
LAX:W6AMT-3} 50 1 192 255 6 5 3600 64 60 3 3 180
4 4 900 16 4 7 10 100 18000 1 1 1
```

The following 24 node parameters are displayed in sequence:

No.	Description of Parameter	Default	Min	Max
1.	Max destination list entries	50	1	400
2.	Worst quality for auto-updates	1	0	255
3.	Channel 0 (HDLC) quality	192	0	255
4.	Channel 1 (RS232) quality	255	0	255
5.	Obsolescence count initializer	6	0	255
6.	Obs. count minimum to be broadcast	5	1	255
7.	Auto-update broadcast interval	3600	0	65535
8.	Network "time-to-live" initializer	64	0	255
9.	Transport timeout (seconds)	60	5	600
10.	Transport maximum tries	3	2	127
11.	Transport acknowledge delay (seconds)	3	1	60
12.	Transport busy delay (seconds)	180	1	1000
13.	Transport requested window size	4	1	127
14.	Congestion control threshhold	4	1	127
15.	No-activity timeout(seconds)	900	0	65535
16.	Link digipeater wait "DWAIT" (10ms)	16	0	127
17.	Link T1 timeout "FRACK" (seconds)	4	1	15
18.	Link tx window size "MAXFRAME"	7	1	7
19.	Link maximum tries (0=try forever)	10	0	127
20.	Link T2 timeout (10ms increments)	100	0	65535
21.	Link T3 timeout (10ms increments)	18000	0	65535

22.	AX.25 digipeating (1=enabled)	1	0	1
23.	Validate callsigns (1=enabled)	1	0	1
24.	Station ID beacons (1=enabled)	1	0	1

To change node parameters, use PARMS followed by a series of decimal parameter values in the same sequence described above:

```
PARMS * * 224 * 8 6
LAX:W6AMT-3} 50 1 224 255 8 6 3600 64 60 3 3 180
4 4 900 16 4 7 10 100 18000 1 1 1
```

To change a particular parameter, you must enter values for all preceding parameters as well. Entering "*" instead of a value causes the corresponding parameter value to be left unchanged. If fewer values are given then there are parameters, then the trailing parameters are also left unchanged. Before using the PARMS command to change node parameters remotely, you must validate your credentials as a control operator by using the SYSOP command...otherwise, the node parameters are left unchanged.

5.7. RESET Command

The RESET command allows an authorized control operator to perform a warm-start reset of the NET/ROM firmware. The command is:

```
RESET 32767
```

Any other form of the RESET command is ignored. Before using this command remotely, you must validate your credentials as a control operator by using the SYSOP command...otherwise, the RESET is ignored.

WARNING: This command is dangerous, and should be used only as a last resort. The RESET command instantly terminates all links and circuits at the node (including the control-operator's own connection).

5.8. Command Interpreter Messages

The following messages may be displayed by the command interpreter:

```
Connected to callsign
Busy from callsign
Failure with callsign
Invalid command (CONNECT IDENT NODES PARMS USERS)
Invalid callsign
Node busy
Circuit table full
Link table full
Host table full
Routing table full
```

6. Host Interface

The node's host terminal may be used to enter both host command lines and information lines. Lines may be up to 256 characters long, including the terminating carriage-return. BS or DEL may be used to delete the last one or more characters typed on a line; CTRL-U or CTRL-X may be used to delete the entire line.

Lines that don't start with an ESC are interpreted as information lines. If the host interface is connected, information lines are sent across the connection; otherwise, they are discarded.

Host command lines begin with an ESC character (echoed as "* "). Valid host commands are: C, D, P, T, and Y.

6.1. ESC-C - connect

The ESC-C command connects the host terminal to the node. When connected, the host terminal acts like a user that has been uplinked to the node. All ordinary node commands (CONNECT, IDENT, NODES, PARMS, RESET, SYSOP, and USERS) may then be entered as information lines. However, the host connection automatically has control operator privileges, so using the SYSOP command is unnecessary.

NOTE: The host terminal connection (like any uplink) is automatically disconnected after 15 minutes of no activity.

6.2. ESC-D - disconnect

The ESC-D command disconnects the host terminal from the node.

NOTE: For unattended operation, be sure to disconnect the host interface with ESC-D!

6.3. ESC-P - password string

The ESC-P command sets the "password string" used by the SYSOP command to validate the credentials of control operators. The phrase may be up to 80 characters long (any excess is ignored), and may include spaces and control characters (except for CR and LF). Upper- and lower-case letters are treated as distinct from one another in the password string.

Note that the random numbers returned by the SYSOP command will always correspond to valid non-space character positions of the password string. For maximum security, it is a good idea to use a password string that is close to the maximum length of 80 characters, and doesn't contain too many spaces.

ESC-P with no parameter displays the current password string.

6.4. ESC-T - transmitter key-up delay

The ESC-T command sets the transmitter key-up delay (TXDELAY), which is the time interval allowed by the node between asserting push-to-talk and starting to transmit data on the HDLC port. ESC-T expects a decimal integer parameter in the range 0 255 which defines the delay in 10-millisecond increments. The default value is 30 (i.e., 300 milliseconds).

ESC-T with no parameter displays the current setting.

6.5. ESC-Y - enable/disable host connections

ESC-Y1 enables the host interface for incoming connections. ESC-Y0 disables the host interface for incoming connections (default). ESC-Y displays the current host interface state (0 or 1).

NOTE: For unattended operation, be sure to disable the host interface with ESC-Y0!

6.6. Host Interface Messages

The following messages may be displayed by the host interface:

```
CONNECTED to callsign
DISCONNECTED fm callsign
CONNECT REQUEST fm callsign
INVALID COMMAND
```

7. Installation Instructions

This section provides a step-by-step checklist for installing a new NET/ROM node. For a hassle-free installation, be sure to follow the instructions carefully.

7.1. Hardware Setup

7.1.1. Verify TNC-2 rev. 2

NET/ROM requires hardware using TAPR TNC-2 revision 2 (or later) circuitry. Late-model TAPR kits and all commercially manufactured "clones" use this circuitry. However, a few early-model TAPR kits were shipped with the version 1 circuit board, and these must be upgraded with the version 2 modifications that are available from TAPR.

7.1.2. Upgrade to 32K of RAM

For most installations, NET/ROM also should be installed in a TNC-2 with 32K of RAM. It will run with 16K, but will run short of memory under moderate-to-heavy traffic loads.

Most TNC-2s manufactured prior to 1987 were originally equipped with only 16K of RAM. Inasmuch as the latest version of TAPR firmware requires 32K, however, many TNC-2s have already been upgraded to 32K.

To upgrade a 16K TNC-2 to 32K:

* Remove U24 and U25 (both are 8K RAMs, type 6264).
* On the bottom of the circuit board, cut the trace between the center and top positions of JMP12.
* Add a wire connecting the center and bottom positions of JMP12. * Install one 32K RAM IC (type 43256 or 62256) in U25. (If not available locally, may be obtained from TAPR for $20.00.)

7.1.3. Increase time constant of PTT failsafe timer

All tested TNC-2s have a push-to-talk failsafe timer which limits key-down time to approximately 10 12 seconds maximum. This value is too short for NET/ROM use at 1200 baud, in our experience, and can cause truncation of crosslink transmissions and routing broadcasts. We strongly recommend increasing the failsafe timeout interval to approximately 60 seconds. To do this, simply replace capacitor C31 with a 47 microfarad radial-lead electrolytic capacitor rated at 15 WVDC or higher. Be sure to observe proper polarity.

7.1.4. Set 4.9 MHz CPU clock

TNC-2's are normally set up for slow CPU clock speed (2.4576 MHz). Although NET/ROM will run reliably at this speed, performance is noticeably improved by changing to high CPU clock speed (4.9152 MHz). Although this is somewhat faster than the rated speed of some TNC-2 parts, we have tested NET/ROM with numerous TNC-2s (including clones from several manufacturers), and none failed to operate reliably at the higher clock speed.

To change a TNC-2 to high clock speed:

* On the bottom of the circuit board, cut the trace connecting the center and right positions of JMP2.
* Add a wire connecting the center and left positions of JMP2.

NOTE: For the MFJ 1270B, the jumpering is different. This may also be true for other TNC-2 "not-quite-clones" so check your TNC documentation carefully.

7.1.5. Wire DCD-B to RS232 port

The following modification is required for TNCs that will be used in dual- or multi-channel NET/ROM configurations. Since it does not impair normal operation in any way, we recommend it for all TNCs to be used with NET/ROM...you may want to upgrade to dual-channel operation later.

To make this modification, connect one end of a wire to pin 23 of the RS232 connector. Connect the other end of the wire to pins 1-2-3 of JMP9 (these three pins are already hooked together on the circuit board).

This modification allows the NET/ROM firmware to be configured for multi-channel operation by jumpering RS232 pins 10 and 23 together in the TNC-to-TNC cable.

7.1.6. Upgrade U3 op-amp for 9600-baud operation

Most TNC-2s use an LM324 op-amp (U3) to generate bipolar RS232 output signals. In our experience, most LM324s do not have sufficient slew rate for reliable operation at 9600 baud. This can be remedied easily, and we strongly recommend the fix.

Simply replace the LM324 at U3 with either a TL074 or TL084 IC (manufactured by Texas Instruments and perhaps others).

7.1.7. Set baud rate switches

Follow the switch-setting instructions in the TNC-2 manual. We have performed extensive reliability testing of NET/ROM at HDLC and RS232 baud rates up to 9600; it runs reliably at these high baud rates even at slow CPU clock speed, although we strongly advise using 4.9 MHz CPU clock for reasons of efficiency.

For dual- or multi-channel operation, we strongly suggest setting the RS232 speed at 9600 baud it makes a big difference in cross-channel performance! Be sure to upgrade the U3 op-amp, however.

7.1.8. Wire TNC-to-terminal cable

To connect a host terminal to the TNC-2, almost any standard RS232 cable will do (as long as pins 9, 10, and 23 are not used).

7.1.9. Make sure the TNC still works...

Connect a terminal to the TNC, power it up, and make sure that you get a sign-on message and that the unit still appears healthy. If it doesn't, then either (1) you have made an error; (2) you have installed a bad IC; or (3) your TNC won't run at the fast CPU clock speed.

7.1.10. Finally, install NET/ROM

NET/ROM is distributed in the form of a 27C256 EPROM which simply plugs into the ROM socket (U23) of the TNC-2 in place of the standard TAPR firmware ROM. Be very careful when inserting the new EPROM, making sure that pin 1 is oriented correctly, and that none of the pins are bent under the IC.

The node callsign is "hard-coded" into each NET/ROM EPROM, and cannot be changed. If you must change the node's callsign, you will have to order a new EPROM.

Note: Be certain to save the original ROM you may need it if you ever want to recalibrate the TNC-2 modem or to restore regular TNC functionality.

7.2. Parameter Setup

After setting up the TNC-2 hardware, connect a terminal to the RS232 port. Power up the TNC-2 and make sure you see the NET/ROM sign-on message. Then perform the following steps:

7.2.1. Verify the node's callsign

The callsign of the node (as encoded into the EPROM) is displayed in the NET/ROM sign-on message. Make sure it is correct!

7.2.2. Connect the host terminal to the node

Enter ESC-C followed by a carriage-return. This connects the host terminal to the node's command interpreter. You will see the message: "CONNECTED to nodecall".

7.2.3. Enter the node's mnemonic identifier

Use the IDENT command to enter the mnemonic identifier of the node, which can be up to six characters long. Don't use punctuation or non-printing control characters in the identifier, and don't use an identifier that "looks like" a valid amateur callsign. (Suggestion: three-letter airport identifiers make nice node mnemonics.)

7.2.4. Enter the password string

Enter ESC-P followed by a "password string" up to 80 characters long. It is best to pick a string that occupies the full 80 characters, or close to it, and doesn't contain too many spaces. The string may contain any ASCII characters except CR and LF...even non-printing control characters are legal. You must remember the password string in order to perform privileged control operator functions remotely. Don't forget it unless you enjoy trips to the site!

7.2.5. Prepare the node for unattended operation

Enter ESC-D to make sure the host interface is disconnected. Enter ESC-Y0 to disable host connections. You should always remember to do these two things before you disconnect the host terminal.

7.3. Dual- or Multi-Channel Operation

To install a dual- or multi-channel NET/ROM node, you should follow the previously-described steps for each TNC. Make certain that each TNC has a different callsign (often, only the SSID suffix changes). Verify that each TNC is functioning correctly as a single-channel node before attempting to interconnect the TNCs.

For a dual-channel node, simply connect the two TNCs together, using a special RS232 cable wired as shown in the diagram. (Don't try to use the host-terminal cable it won't work!)

To interconnect three or more TNCs as a multi-channel node, you will have to make up a diode-matrix coupler. A schematic for a three-channel coupler is shown below. It uses 12 diodes (1N4148 or equivalent). A four-port coupler is similar, but requires 24 diodes, and is probably the maximum practical configuration. [Hint: the formula for the number of diodes is 2*N*(N-1).]

8. Appendix A: NET/ROM Protocols

8.1. Inter-Node HDLC Frame Layout

The HDLC frame structure used by NET/ROM for its inter-node crosslinks is illustrated in the diagram.

Each frame consists of a standard AX.25 link header, followed by a 15-byte network header and a 5-byte transport header. The network header contains the information needed for automatic routing, while the transport header supports end-to-end error and flow control for circuits

8.2. Transport-Layer End-to-End Protocol

The Circuit Manager implements a conventional "sliding window protocol" in order to provide end-to-end flow and error control for each transport circuit. The protocol is similar to AX.25, but with these major differences:

* Receive window size is negotiated, and usually greater than 1. * 8-bit sequence numbers, allowing window sizes up to 127 frames. * Selective NAKing is supported.

Six different transport-layer message types are supported:

* Connect Request
* Connect Acknowledge
* Disconnect Request
* Disconnect Acknowledge
* Information
* Information Acknowledge

These are described in greater detail below.

8.2.1. Connect Request

A Connect Request is used to initiate a new transport circuit between the originating node and the destination node, on behalf of the originating user. The circuit index is the subscript of a circuit table entry in the originating node. The circuit ID is a serial number used to qualify the circuit index, in order to eliminate any possible ambiguity in identifying the circuit. The proposed window size specifies the maximum receive window size (in frames) that the originating node is prepared to accomodate.

8.2.2. Connect Acknowledge

A Connect Acknowledge is used to respond to an incoming Connect Request. If the high-order bit of the opcode byte is set, it indicates that the Connect Request is being refused; otherwise, it is being accepted. The accepted window size indicates the negotiated size of the receive window for this circuit, and will never exceed the proposed window size of the Connect Request.

8.2.3. Disconnect Request

A Disconnect Request is used to request the termination of a transport circuit, and may be sent by the node at either end of the circuit.

8.2.4. Disconnect Acknowledge

A Disconnect Acknowledge is used to acknowledge a Disconnect Request.

8.2.5. Information

An Information message is used to pass user information across a transport circuit. Because AX.25 frames are limited to 256 bytes and the combined network and transport header overhead totals 20 bytes, the maximum size of the information field is 236 bytes. NET/ROM automatically fragments and reassembles any user-supplied link-layer information frames that exceed 236 bytes in order to meet this constraint.

Each Information message also serves as a "piggybacked" Information Acknowledge. The Tx Sequence Number identifies the current information, and the Rx Sequence Number specifies the next incoming information expected.

If the choke flag is set (bit 7 of the opcode byte), it indicates that this node cannot accept any more Information messages until further notice. If the NAK flag is set (bit 6 of the opcode byte), it indicates that a selective retransmission of the frame identified by the Rx Sequence Number is being requested. If the more-follows flag is set (bit 5 of the opcode byte), it indicates that the information is a fragment of a long information frame, and must be reassembled with one or more following information messages by the destination node.

8.2.6. Information Acknowledge

An Information Acknowledge is used to acknowledge incoming Information messages. The Rx Sequence Number specifies the next incoming information expected.

If the choke flag is set (bit 7 of the opcode byte), it indicates that this node cannot accept any more Information messages until further notice. If the NAK flag is set (bit 6 of the opcode byte), it indicates that a selective retransmission of the frame identified by the Rx Sequence Number is being requested.

8.3. RS232 Interconnect Protocol

For multi-channel nodes, information is passed among the interconnected TNCs via their RS232 ports. The interconnect operates using the same link-, network-, and transport-layer protocols as normal HDLC crosslinks, except that a simple asynchronous variant of HDLC is employed.

Each frame is preceded with an ASCII STX (instead of an HDLC flag), and terminated by an ETX plus a one-byte checksum (instead of an HDLC frame-check sequence). Any embedded STX, ETX, or DLE characters within the body of the frame are prefixed by a DLE character (this takes the place of normal HDLC "bit stuffing").

When two TNCs are connected using the recommended TNC-to-TNC cable, communications between the two TNCs is full-duplex and extremely fast (especially at 9600 baud).

When three or more TNCs are interconnected using the recommended diode-matrix coupler circuit, intercommunications between the TNCs is essentially half-duplex and utilizes CSMA/CD arbitration. Consequently, do not expect performance to be quite as spectacular as it is with the dual-channel configuration.

9. Appendix B: NET/ROM Routing

9.1. Routing Table Structure

The routing table maintained by each node consists of two dynamically allocated threaded lists: the destination list and the neighbor list. The destination list contains an entry for every other node "known" to this node. (This is the the list displayed by the NODES command.) The neighbor list contains an entry for only those "neighboring" nodes to which this node has a direct link.

For each node in the destination list, the routing table up to three routes to that destination node. In this context, a route simply identifies a neighboring node that is a step closer to the ultimate destination. For each route, the destination list maintains a quality value which quantifies the relative desirability of each route. NET/ROM maintains route quality as an integer which ranges from 255 (best) to 0 (worst). Routes are maintained in sorted order by quality, and NET/ROM always attempts to use the highest-quality route available. It also keeps an obsolescence count , which enables NET/ROM to purge paths from its routing table when it has become unuseable and remained so for a protracted period of time.

Observe that the routing table does not contain the entire path to each known destination (this is unnecessary, and would require too much memory), but just a list of neighboring nodes that are reasonable choices for a next step enroute to the destination. You can ask to see the routes to a particular destination node by using a NODES command that specifies the callsign or mnemonic identifier of the destination.

9.2. Network-Layer Routing Algorithm

The Routing Manager analyzes the network header of each incoming 'CF'-frame, and determines how to route that frame. The network header contains the callsign of the destination node and a "time-to-live" counter. (For the layout of the network header, see the diagram on the preceding page.) The routing algorithm is straightforward, and is described in the flow diagram.

9.3. Automatic Routing Table Updates

Each node makes a periodic broadcast of information from its routing table in order to provide the basis of routing table updates at neighboring nodes. The broadcast is normally made once an hour, although the frequency may be changed with the PARMS command by the control operator.

The routing broadcast takes the form of one or more AX.25 UI-frames tagged with PID='CF'. The source callsign identifies the broadcasting node, and the destination callsign is "NODES".

Up to 11 destinations are packed into each UI-frame, and the node broadcasts as many such frames as required to send every eligible destination in its routing table.

When a node receives an auto-routing broadcast UI-frame from one of its neighboring nodes, it analyzes the contents and makes appropriate updates to its own routing table. This process is more complex than one might think. The receiving node utilizes a series of heuristic rules to keep the size of its routing table manageable and to try to avoid "loops" and other undesirable routes. Here is a summary of the most important rules used in processing auto-routing update broadcasts:

* If the worst quality for auto-updates parameter (set by PARMS) is zero, all auto-update broadcasts are ignored.

* If the if the PID of the UI-frame is not 'CF' hex, or if the first byte of its contents is not the proper signature ('FF' hex), the frame is ignored.

* A direct route is assumed to exist to the node that originated the broadcast. The quality of this route is set in accordance with the channel quality parameter (set by PARMS) appropriate to the channel (HDLC or RS232) over which the broadcast was received.

* For each destination node listed in the broadcast, an indirect route is assumed to exist via the node who originated the broadcast. The quality of this route is calculated by combining the broadcast quality with the channel quality parameter appropriate to the channel over which the broadcast was received. The qualities are multiplied, normalized, and rounded as shown in the following formula:

  routequality = ((broadcastquality x channelquality) + 128) / 256

* An indirect route is considered to be a trivial loop if the callsign of the best-route neighbor node in the broadcast matches the callsign of the receiving node. Trivial loop routes are assigned a quality value of zero, so they are used only as a last resort. Quality-zero routes are never included in outgoing auto-routing broadcasts.

* Only the three higest-quality routes to a destination are retained.

* Any route with quality less than the worst quality for auto-updates parameter (set by PARMS) is ignored.

* If the number of entries in the destination list is greater than or equal to the max destinations parameter (set by PARMS), then no additional destinations will be added.

Each route in the routing table has an obsolescence count which is initialized to the "obsolescence count initializer" value (set by PARMS) whenever the route is added or updated as the result of an auto-routing broadcast. The count is also reinitialized to this value whenever the route is actually used successfully. The default initializer value is 6. Periodically, NET/ROM scans through the routing table and decrements the obsolescence count of every route in the table this scan occurs with the same frequency as routing broadcasts, normally once each hour. The obsolescence count of a route is also decremented whenever the route fails in actual use. If the obsolescence count of a route is decremented to zero, the route is deleted from the routing table.

A routing table entry created by the automatic routing update mechanism can never have an obsolescence count of zero, since such an entry is automatically purged from the table when its count reaches zero. When a route is entered into the routing table manually with the NODES+ command, however, it is possible to set the route's obsolescence count to zero. This has special significance: it marks the route as permanent. Such a permanent route will never be updated or deleted by the auto-update mechanism. It can, however, be deleted manually (with the NODES- command).

10. Appendix C: NET/ROM Parameters

This section describes in detail the function of the 24 parameters that the control operator can change remotely using the PARMS command.

Parameter 1
Max destination list entries **(default=50, minimum=1, maximum=400)**
Defines the maximum allowable number of destinations in the node's routing table. Each destination consumes 32 bytes of RAM. The control operator can use this parameter to limit the amount of RAM that is allocated to the routing table, thus ensuring that sufficient space remains for frame buffering.

Parameter 2
Worst quality for auto-updates **(default=1, minimum=0, maximum=255)**
Defines the poorest route quality that will be automatically added to the node's routing table. The control operator can use this parameter to limit the automatic routing update function to accept only higher-quality routes. In addition, the automatic update function can be disabled altogether by setting this parameter to zero.

Parameter 3
Channel 0 (HDLC) quality **(default=192, minimum=0, maximum=255)**
Defines the quality of the radio channel connected to the node's HDLC port. The control operator should set this parameter to an appropriate quality value in accordance with the speed, reliability, and congestion anticipated on the channel. The default value of 192 is appropriate for a 1200-baud user-accessible frequency...if the actual channel quality is better (e.g., a UHF backbone frequency) or worse (e.g., an HF link), the parameter value should be changed accordingly.

Parameter 4
Channel 1 (RS232) quality **(default=255, minimum=0, maximum=255)**
Defines the quality of the TNC-to-TNC interconnect channel connected to the node's RS232 port. The control operator should set this parameter to an appropriate quality value in accordance with the speed, reliability, and congestion anticipated on the channel. The default value of 255 is appropriate for a 9600-baud two-modem interconnect cable...if the actual channel quality is worse (e.g., a three- or four-port interconnect, or a satellite link), the parameter value should be changed accordingly.

Parameter 5
Obsolescence count initializer **(default=6, minimum=0, maximum=255)**
Defines the initial value given to the obsolescence count of a route that has been newly added or updated by the node's automatic routing table update mechanism. The obsolescence count of a route is also reinitialized to this value whenever the route is actually used successfully. The obsolescence count of a route is decremented once each auto-update broadcast interval (see parameter 7 below). However, such periodic decrementing of route obsolescence counts can be disabled altogether by setting this parameter to zero.

Parameter 6
Obsolescence count minimum to be broadcast **(default=5, minimum=1, maximum=255)**
Defines the minimum obsolescence count threshhold below which a route will not be included in the node's automatic routing broadcasts. The purpose of this threshhold is to prevent the node from broadcasting "stale" routing information to other nodes. Under normal circumstances, this parameter should be assigned a value no greater than the value of parameter 5 (obsolescence count initializer); if it is greater, the node's broadcasts will include no destinations other than itself.

Parameter 7
Auto-update broadcast interval (seconds) **(default=3600, minimum=0, maximum=65535)**
Defines the number of seconds between automatic routing broadcasts issued by the node. The default value of 3600 specifies an hourly broadcast. In addition, broadcasts can be disabled altogether by setting this parameter to zero.

Parameter 8

Network "time-to-live" initializer **(default=64, minimum=0, maximum=255)**

Defines the initial value of the "time-to-live" field in the Network Header of all network-layer frames originated by this node. The time-to-live field is decremented by each intermediate node that relays the frame. If the time-to-live value ever reaches zero, the frame is discarded. This protects the network against frames persisting forever as the result of a routing loop. The value of this parameter should be a bit larger than number of "hops" in the longest legitimate route in the network.

Parameter 9

Transport timeout (seconds) **(default=60, minimum=5, maximum=600)**

Defines the number of seconds between transport-layer retries.

Parameter 10

Transport maximum tries **(default=3, minimum=2, maximum=127)**

Defines the maximum number of transport-layer tries attempted before a circuit failure is reported.

Parameter 11

Transport acknowledge delay (seconds) **(default=3, minimum=1, maximum=60)**

Defines the number of seconds' delay used by the transport layer from the time it receives an information message until it sends an information-acknowledge message. The purpose of this delay is to give the acknowledgement an opportunity to be "piggybacked" upon an outgoing information message.

Parameter 12

Transport busy delay (seconds) **(default=180, minimum=1, maximum=1000)**

Defines the maximum number of seconds that the transport layer will remain "choked" as the result of an incoming message that has the choke flag bit set. The purpose of this timeout is to prevent an indefinite hangup in the event that the "unchoke" message is lost.

Parameter 13

Transport requested window size (frames) **(default=4, minimum=1, maximum=127)**

Defines the maximum number of incoming out-of-sequence information messages that the transport layer will buffer while waiting for the next expected information message to arrive. Also defines the maximum number of outgoing information messages that the transport layer will send without receiving acknowledgement.

Parameter 14

Congestion control threshhold (frames) **(default=4, minimum=1, maximum=127)**

Defines the maximum allowable backlog of messages that the transport layer will buffer before it sends a choke message. Also defines the maximum allowable backlog of frames that the link layer will buffer before it sends an RNR control frame.

Parameter 15

No-activity timeout (seconds) **(default=900, minimum=0, maximum=65535)**

Defines the maximum number of seconds that a transport-layer circuit or a link-layer connection can remain idle (i.e., no information transfer in either direction) before it is automatically disconnected.

Parameter 16

Link digipeater wait "DWAIT" (10ms increments) **(default=16, minimum=0, maximum=127)**

Defines the extra clear-channel interval (measured in 10-millisecond increments) that the link-layer requires before keying up the transmitter to send frames originated by the node. (This extra interval is not required to send digipeated frames.) For networks in which digipeating is seldom used, the control operator may wish to set this parameter to zero.

Parameter 17

Link T1 timeout "FRACK" (seconds) **(default=4, minimum=1, maximum=15)**

Defines the number of seconds between link-layer retries. When digipeating is used, this value is multiplied

by 2D+1, where D is the number of digipeaters.

Parameter 18
Link transmit window size "MAXFRAME" (frames) **(default=7, minimum=1, maximum=7)**
Defines the maximum number of outgoing information frames that the link layer will send without receiving acknowledgement.

Parameter 19
Link maximum tries **(default=10, minimum=0, maximum=127)**
Defines the maximum number of tries that the link layer will attempt before reporting a link failure. If this parameter is set to zero, the link layer will retry forever (not recommended).

Parameter 20
Link T2 timeout (10ms increments) **(default=100, minimum=0, maximum=65535)**
Defines the delay (measured in 10-millisecond increments) used by the link layer from the time it receives an information frame until it sends an acknowledgement (RR, RNR, or REJ) control frame. The purpose of this delay is to give the acknowledgement an opportunity to be "piggybacked" upon an outgoing information frame.

Parameter 21
Link T3 timeout (10ms increments) **(default=18000, minimum=0, maximum=65535)**
Defines the maximum no-activity period (measured in 10-millisecond increments) permitted by the link layer before it issues a poll to make sure the link is still intact. This timeout is also used to break link-layer choke deadlocks.

Parameter 22
AX.25 digipeating (1=enabled, 0=disabled) **(default=1, minimum=0, maximum=1)**
Defines whether or not the node will perform AX.25 digipeating. The default value of 1 causes digipeating to be enabled.

Parameter 23
Validate callsigns (1=enabled, 0=disabled) **(default=1, minimum=0, maximum=1)**
Defines whether or not the node will perform validation checks on amateur callsigns. The default value of 1 causes callsign validation to be enabled.

Parameter 24
Station ID beacons (1=enabled, 0=disabled) **(default=1, minimum=0, maximum=1)**
Defines whether or not the node will broadcast station-identification beacons every 9 minutes and 59 seconds. The default value of 1 causes this feature to be enabled.

11. Appendix D: Miscellaneous Operating Notes

11.1. Fixed Limitations

The following fixed limits apply to the current version of NET/ROM:

* Maximum number of links per node: 25
* Maximum number of circuits per node: 20

11.2. Watchdog Timers

Some digipeater operators have been known to incorporate a "watchdog timer" circuit to prevent the possibility of a TNC hangup due to software failure. The simplest approach is to rig up a 555 timer that resets the TNC every 10 or 15 minutes.

Trying to use such a "brute force" approach on a NET/ROM node would be disasterous. Reseting a NET/ROM node causes instant termination of all uplinks, downlinks, and crosslinks to or from that node. Don't even consider it!

A somewhat more sophisticated approach is to set up a retriggerable timer triggered by the TNC's push-to-talk output. The idea is to reset the TNC only if PTT has not been activated for some period of time. This approach will probably work OK with NET/ROM as long as the timeout period is at least 15 minutes or so. The automatic station-identification broadcasts every 9 minutes and 59 seconds should prevent such a timer from firing unless something goes terribly wrong. If you use this approach, don't turn off the station-identification feature!

Our experience is that the hardware and firmware are extremely reliable, and consequently this sort of timer is rarely necessary.

11.3. Long Frames

To achieve best efficiency using NET/ROM, users may wish to set their TNC's maximum frame length parameter ("PACLEN") to 236 bytes or less. The maximum allowable AX.25 information frame is 256 bytes. Since NET/ROM inter-node protocols impose an additional overhead of 20 bytes, the transport-layer information field is limited to a maximum of 236 bytes. User frames longer than 236 bytes are automatically fragmented into two transport frames by the originating node, and reassembled into one long frame again by the destination node. This fragmentation and reassembly is completely transparent to users of the network, so the only disadvantage of sending long frames (>236 bytes) is some additional overhead.

11.4. Callsign Validation

NET/ROM includes a callsign validation algorithm whose purpose is to protect the network against invalid amateur callsigns in commands, link headers, routing table entries, etc. To qualify as a valid amateur callsign, a callsign must meet the following criteria:

* Length of callsign (excluding SSID) must be between 4 and 6.
* All characters must be letters or digits (no punctuation or control).
* The callsign must contain either 1 or 2 digits.
* The last character of the callsign must be a letter (not a digit).
* The SSID suffix (if present) must be in the range 0 to 15.

In practice, one of the most useful functions of such callsign validation is to prevent uplinks from improperly-

initialized user TNCs which are using a bad callsign (most commonly, "NOCALL", "PK64", or blank).

The PARMS command includes a parameter that allows a control operator to defeat this callsign validation if desired. However, we strongly advise against disabling callsign validation in NET/ROM, and we disclaim any responsibility for problems that occur in nodes operating with callsign validation disabled.

11.5. Multi-Connect Operation

Since many TNCs now support multiple AX.25 connections, you may wish to establish multiple simultaneous uplinks to your local NET/ROM node. This can be done successfully, but some precautions are in order. The AX.25 protocol is not capable of supporting multiple simultaneous connections in which both originator and destination callsigns are identical. Consequently, to achieve multiple concurrent uplinks from your TNC to a node, you must employ one of the following tactics:

* If your TNC is capable of supporting independent originator callsigns ("MYCALLs") on each channel, then you can establish different callsigns for each channel (typically, your call with SSIDs -0, -1, -2, etc.) and then uplink with impunity. Since each uplink will have a unique originator callsign, there will be no protocol ambiguity. This is the best approach...but unfortunately, many TNCs are incapable of assigning independent originator callsigns to each channel.

* If your local NET/ROM node (let's say it's "W6AMT-3") has a mnemonic identifier (let's say it's "LAX"), then the node will actually respond to seventeen different names: its callsign (W6AMT-3) plus its identifier with any valid SSID (LAX, LAX-1, LAX-2,...,LAX-15). Consequently, you can establish multiple concurrent uplinks to the node as long as you are careful to call the node by a different name when establishing each uplink.

11.6. Assignment of Channel Quality Values

For both channel 0 (HDLC) and channel 1 (RS232), NET/ROM maintains channel quality parameters which are set by PARMS and used in route quality calculations. The quality of a route segment is a value from 0 to 255 (255 is best, 0 is worst), and the quality of a route is the normalized product of the quality of its segments.

Channel quality depends upon baud-rate, congestion, and many other factors. It is up to the NET/ROM control operators to assign reasonable quality values to the various available channels in order to allow NET/ROM's optimum routing algorithm to make the most efficient routing choices. As a starting point, we suggest the following values to be assigned to channel quality parameters:

Channel Description	Quality	% Perfect
9600-baud RS232 wire interconnect (2-port)	255	99%+
9600-baud RS232 satellite interconnect (2-port)	252	98%
9600-baud RS232 wire interconnect (3-port)	248	97%
9600-baud HDLC isolated internode backbone	240	94%
1200-baud HDLC isolated internode backbone	224	88%
1200-baud HDLC user-accessed channel	192	75%
300-baud HDLC HF channel	128	50%
Known loopback or route of unknown quality	0	?

The default channel quality values are quality=192 for channel 0 (HDLC), and quality=255 for channel 1 (RS232). For nodes connected to high-quality backbone channels, you should use PARMS to change the

channel 0 quality to an appropriate value (as illustrated in the table above). Likewise, for multi-channel nodes with satellite interconnects or with 3 or more ports, your should change the channel 1 quality.

The worst possible quality value (quality=0) is reserved by NET/ROM to indicate a trivial loop or route of unknown quality that should be used only as a last resort. Quality 0 paths are never propagated to other nodes via auto-routing broadcasts. In most situations, you should not assign a value of 0 to either of the channel quality parameters.

11.7. Interfacing with a Duplex Repeater

In high-density areas with lots of congestion on packet user frequencies, a duplex packet repeater can improve throughput and reduce collisions significantly in comparison to an ordinary simplex digipeater. A dual-port NET/ROM node can be readily interfaced with such a repeater in such a way as to give users on the duplex repeater access to the rest of the normal simplex network. The diagram illustrates one way in which this can be accomplished.